THE AMERICAN GAS LIGHT JOURNAL

PUBLISHING OFFICE No. 42 PINE STREET

DEVOTED TO THE INTERESTS OF ILLUMINATION, HEATING, MECHANICAL, CHEMICAL AND GENERAL SCIENCE.

VOLUME XCII., No. 22. Whole No. 1,825. | NEW YORK, MONDAY, MAY 30, 1910. | $3 PER ANNUM, IN ADVANCE.

A. M. CALLENDER & CO., Proprietors. C. H. WADELTON, Manager. THOMAS J. CUNNINGHAM and ELBERT P. CALLENDER, Editors.

ENTERED AT THE POST OFFICE AT NEW YORK, N. Y., AS SECOND-CLASS MATTER.

Published on each Monday of the year, at No. 42 Pine Street, New York City.

Telephone.—2906 John.

Terms of Subscription, Including Postage.—For the United States, $3; Canada, $4 per annum. European countries, $5 (£1—25 francs).

Remittances should be made either by post office order, express money order, registered letter, or bank draft on New York, payable to the order of A. M. Callender & Co.

Correspondence.—Wishing to make this JOURNAL a gazette of intelligent discussion to those of our readers who may wish to gain or give information on the subjects to which its columns are devoted, correspondence is solicited for publication from all who make the study of those subjects a pleasure or a profession.

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The American News Company, Nos. 39 and 41 Chambers street, New York, are agents for this JOURNAL. Newsdealers will send orders to them. All payments to be made in advance. Single copies, 10 cents.

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[OFFICIAL NOTICE.]

Sixth Annual Meeting, Iowa District Gas Association.

IOWA DISTRICT GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
DES MOINES, IA., May 28th, 1910.

To the Members, Iowa District Gas Association: The Sixth Annual Meeting of the Iowa District Gas Association will be held in Sioux City, Ia., June 15th, 16th and 17th, 1910. The meeting will be called to order at 10 A.M., June 15th, by the President, Mr. Geo. H. Waring, of Omaha. The following papers will be read:

"The Gas Company's Policy Toward the Public," by Mr. Campbell Fair, Oskaloosa, Ia.

"Depreciation," by Mr. R. Shacklette, Detroit, Mich.

"How we Increased Gas Sales in Lincoln," by Mr. J. E. Shuff, Lincoln, Neb.

"Boiler Fuel Leaks," by Mr. J. B. Myers, Omaha, Neb.

"Advantages of High Pressure in a Low Pressure System," by Mr. B. C. Adams, Lincoln, Neb.

"Distribution in a Small Gas Plant" (Special references to general operation, street leakage, station meter, etc.), by Mr. A. W. Borden, Hasting, Neb.

The following standing committees will report: New Business; Gas Works' Construction; Gas Manufacture; Distribution; Uniform System of Accounts.

In addition the following special features will form part of the programme:

1. A lecture by Mr. Rufus C. Dawes.
2. A lecture by Mr. Norman Macbeth, illustrated with lantern slides, on "Illuminating Engineering Factors in Gas Illumination."
3. A lecture by Mr. J. B. Klump, on the "A B C. of Calorimetry."

The headquarters will be at Hotel West. Best accommodations are always obtained by reservation secured in advance. For further information address, G. I. VINCENT, Sec'y and Treas.

[OFFICIAL NOTICE.]

Third Annual Convention, Canadian Gas Association.

CANADIAN GAS ASSOCIATION,
OFFICE OF THE TREASURER,
WOODSTOCK, CANADA, April 19, 1910.

The Third Annual Convention of the Canadian Gas Association, and the first gas show ever held in Canada, will be held in Alexandria Rink, Hamilton, Ont., June 6th to 11th, inclusive. The Canadian Gas Association indorses to the fullest measure the exhibition.

Yours truly, A. W. MOORE, Secretary.

LIBRARY OF CONGRESS MAY 31 1910 SMITHSONIAN DEPOSIT

BRIEFLY TOLD.

THE FINALS, SOUTHWESTERN, ELECTRICAL AND GAS ASSOCIATION.—Completing our mention of that which happened at the Beaumont (Tex.) meeting of the named Association, it may be noted that the officers elected for the ensuing year were:

President—W. B. Tuttle, San Antonio.
First Vice-President—Jos. E. Carroll, Beaumont.
Second Vice-President—E. T. Moore, Dallas.
Third Vice-President—D. G. Fisher, Dallas.
Secretary—H. B. Head, Stephensville.
Treasurer—A. E. Judge.
Editor Question Box—Dr. A. C. Scott.

Houston was selected as the next meeting place. To show how the members regarded the meeting it is only necessary to here republish the second "Whereas" in the resolutions adopted right before final adjournment:

"*Whereas*, It is the sense of the Association that this has been one of the most important meetings in its history, during which much business of importance has been transacted."

JUNE MEETING, NEW YORK SECTION, ILLUMINATING ENGINEERING SOCIETY.—The June meeting of this Society will be held in its headquarters (29 West 39th street), the evening (8:15) of the 9th prox. Two papers are on the list: "Photometric Units and Nomenclature," by Dr. E. B. Rosa, of the Bureau of Standards, Washington, D. C.; and "Incandescent Electric Lamps as Secondary Standards of Luminous Intensity," by Messrs. Clayton H. Sharp and Preston S. Millar. Secretary Marshall informs us that it is likely both papers will be available in printed form the night of the meeting. Members should bear in mind that this is virtually the annual closing session for the fiscal year, and that the election of officers for the following twelve-month will take place.

CURRENT MENTION—

MR. GEORGE P. DAVIS, Manager of the Mount Clemens (Mich.) Gas Light Company since 1900, has been transferred to the management of the Holland City (Mich.) Gas Company. Mr. Archie Goss, of Iron Mountain, Mich., will succeed Mr. Davis as Manager of the Mt. Clemens plant.

A RECENT issue of the Philadelphia *Inquirer* says that to determine the best way to utilize a large flow of natural gas in the Transylvania (or southeastern) section of Hungary, an accredited commission from the Hungarian government is in the United States, with a view to visiting, for close inspection, our different natural gas producing districts. The Commission is composed of: Maximillian Herrman, Prof. Royal College of Mines, and Messrs. Francis Venutsko and Francis Boehm, expert mining engineers of Hungary. They arrived in this country early the present month and left for Washington the 21st inst., where they will remain until the first week in June, and from there they visit the gas fields of Indiana, Ohio and Pennsylvania, winding up their professional tour in the Texas district. They then return to New York, remaining in this vicinity for a fortnight or so. The discovery of natural gas, in quantities sufficient to make it a profitable undertaking to distribute the same in Hungary, came about through accident, the first vein having been pierced by a driller who was boring for a salt deposit. An investigation disclosed that the drill had penetrated a tremendous collection of gas (the first well disclosed a surface pressure of 1,600 pounds) which Dr. Herrman declares exists in unlimited quantities, covering an area of not less than 500 square miles. The Hungarian government at once assumed charge of the "find," ordered the well capped and appointed the Commission to determine how and where the best practice in the supplying of natural gas on commercial account could be attained. We bespeak for the Commission that attention which the importance of its mission here seems to demand.

ACCORDING to the official figures of the United States government on the subject, the outputs of petroleum for the year 1909 compared with those of the preceding year, showed little change in actual production, but the selling price of same showed a reduction in value of perhaps 9 per cent.

THE fraternity are cautioned against a chap named Edgar M. Watson, who has been swindling gas companies in Massachusetts. His method of procedure was this, as practiced in North Adams, Mass.: He would pretend that he was employed by the gas company as a meter reader and collector, and, having read the meter, if the cash were not at once forthcoming, he would inform the consumer that, if the bill were paid to him immediately, the company would accept its face value, less 20 or other per cent. It was a crude scheme, but it worked well for a week or so among the thrifty housewives. He had an excellent knack of selecting his victims.

THE proprietors of the Allentown (Pa.) Gas Company have just concluded a very successful demonstration of the uses of gas on domestic account, which exhibition lasted several days and nights. The attendance was representative of the "best families" of Allentown, and the results—that is, immediate results—were the sale and placing, during the exhibition week, of two score or more appliances for using gas on other than illuminating account.

A MOST interesting convention was held in Cairo, Ills., about a fortnight ago, which convention was the Fifth Annual Meeting of Illinois Mayors' Association. Cities of the State, to the number of 53, were represented. George Parsons, Mayor of Cairo, delivered an appropriate address of welcome, to which the President, Joseph E. Paden, of Evanston, responded in a way that caused occasional outbursts of applause. A paper that attracted much attention and comment was handed in by W. T. Raleigh, Mayor of Freeport, whose theme was "Public Service Corporations and Their Control." Another feature was the discussion of a resolution (adopted) directing the Association to endeavor to have the Legislature pass a law giving the cities the right to order reductions in the selling rates of gas and electricity. During the debate on this matter one Mayor remarked that it was not likely the Legislature would be over-puissant in this respect, since a measure of that nature might interfere with the perquisites of the State's representatives. The entertainment had was a trip to Mound City and a visit to the wonders in the settlement of Mounds, and a "smoker," at which Mayoral dignity suffered several assaults. We would imagine that the gas men might find it advantageous to have a representative at these "gatherings."

MR. C. M. SCHWAB, finding that he had surplus gas from his coking plant, proposed to pipe that surplus to the cities of Allentown, Easton and Bethlehem, but subsequently found himself barred from that action by the State statutes of 1874, which gave to gas companies all over the State a monopoly of the business of supplying gas, provided the selling rates in such places were at figures which enabled the companies to pay not in excess of 8 per cent. per annum on their shares.

THE Judiciary Committee of the Milwaukee (Wis.) City Council, has been considering a resolution fathered by Ald. Jacob Rummel, who wished or desired that the Milwaukee Gas Company be ordered and compelled to lay gas mains in 47th and 48th streets, between Vliet street and Pabst avenue. At the request of Mr. Sheldon J. Glass, immediate consideration of the measure was postponed to enable him to show that the Company had underway a comprehensive mapping in the instance of main extensions. In his argument Mr. Glass further said that the Company never hesitated to extend its system wherever and whenever such extensions gave any reasonable likelihood of a fair return on the investment, even going to the extent of advancing the cost of the extension after the first 100 feet thereof; also that when the mains reached the point of returning fair interest all the money advanced by householders was returned them.

MAYOR LLEWELLYN JONES (we hope we did not miss any of the "l's" in his name), of Independence, Kas., has selected a utility board (Messrs. Woodson, Pitt, Flournay, Anderson and Bryant), charged with the duty of determining whether or not the gas supplied by the Independence Gas and Coke Company would yield a "sufficient income" to the Company were the authorities to pass an ordinance ordering a reduction of 25 cents or more per 1,000—the present rate is $1.25.

THE latest Company to enter the lists as the operator of an automobile for the speedy transportation of its officials, is the Allentown (Pa.) Gas Company. We presume, and certainly hope, that accident policies have been secured in and upon the persons of Manager Frick and Assistant Manager Davis.

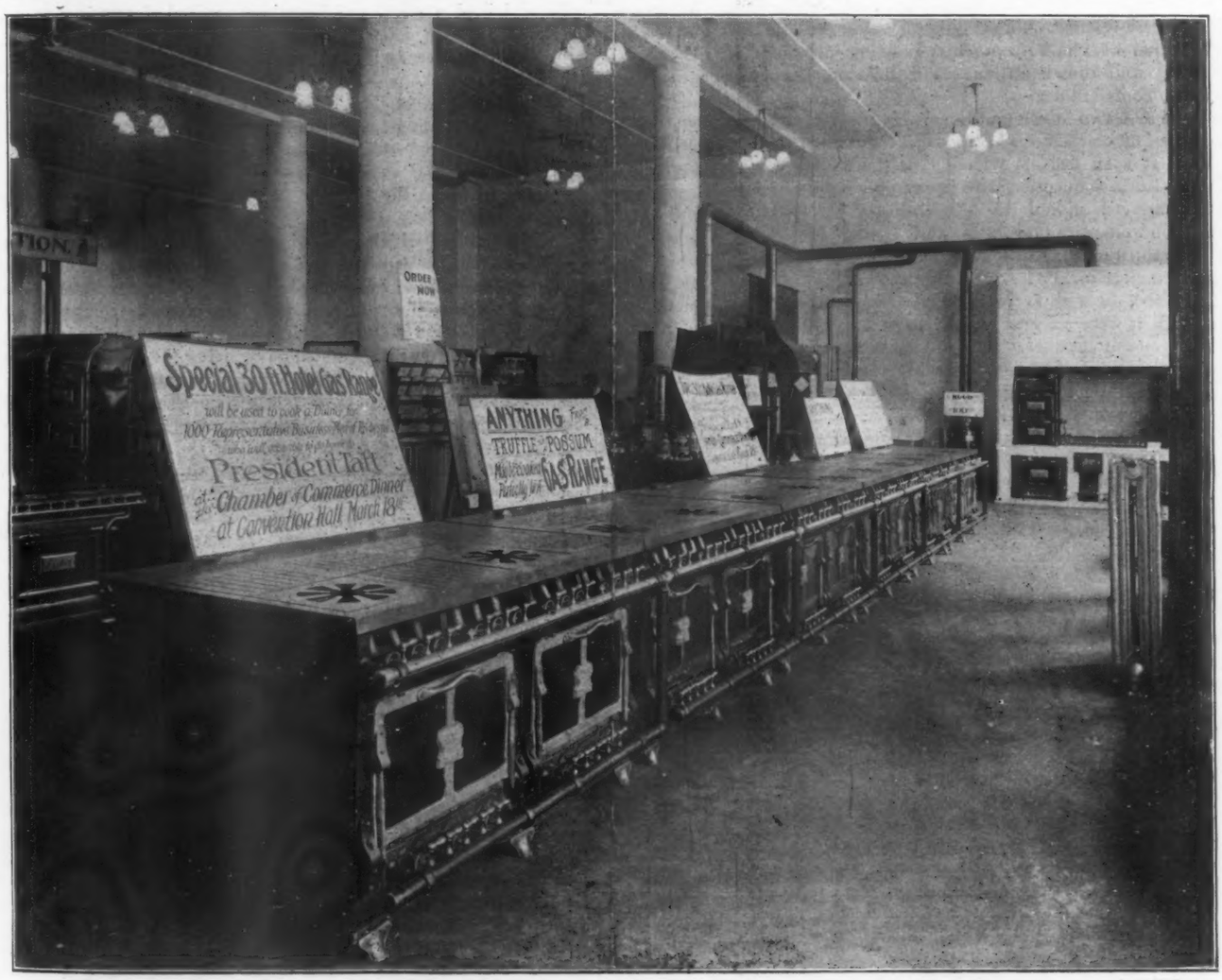
MR. W. K. HARRINGTON, former General Superintendent of Meters, Consolidated Gas Company, New York city, has been appointed Manager of the American Meter Company's New York office. Mr. Harrington is a man of no mean executive ability, and it goes without saying that he is as familiar with a meter and its operation as a watchmaker is knowledgable respecting a watch.

AT the annual meeting of the Woonsocket (R. I.) Gas Company, no change was made in the executive management thereof. President Holden's annual report showed that the Company's business was in a very satisfactory condition, which is the case in fact with every company in which Messrs. Stone and Webster have control.

The Possibilities of Gas in the Kitchens of Hotels.

By Mr. J. C. Thomas.

The writer has often heard it said that Mr. Robert M. Searle, the sure-enough Manager of the Rochester Railway and Light Company, of Rochester, N. Y., rather favored the electric lighting end of that Company's diversified business venturing than the gas lighting section thereof. And the writer has just as often made the reply that as Mr. Searle knew his business pretty well it was quite a safe thing to say that Mr. Searle could be trusted not to play favorites on Company account; quite to the contrary, that he always allowed the public to make the favorite. This latter, of course, is not quite an easy matter to one sustained or situated as Mr. Searle is; for under his domination are: The gas supply, the electric lighting supply, and the transportation of the people over the streets by means of electrically propelled tramways. Thus one readily sees it is not every corporation that so closely appeals to the comfort of its patrons as does the one under consideration. However, to show that Manager Searle is not oblivious or indifferent to using gas, and to spreading widecast the uses to which gas may be put, the writer (even at this late day), and especially since the subject has not been heretofore properly put before the gas people, would call attention to one specific act of Mr. Searle's Company regarding gas as a kitchener on a huge scale.



The annual dinner of the Rochester Chamber of Commerce was this year held, March 18th, in Convention Hall, and the guest of honor was President Taft. The problem of the proper cooking of the food necessary to quiet the appetites of 1,000 people, especially when one remembers the *menu* was an exceedingly elaborate one, and included in its numbers some delicate bits that would be worse than appetizing were they served cold, or *vice versa*. In this extremity Mr. Searle was appealed to with the query: "Can you help us out of our difficulty?" "Difficulty," replied Mr. Searle. "Where is the difficulty?" And the Committee sighed their relief. The upshot of the matter was this, as shown in the illustration, and as provided in the following text, which Mr. Searle, of course, was not slow in causing to be printed in the local newspapers:

An idea of the magnitude of the problem that was solved may be gleaned from the following narrative of the equipment provided. A specially constructed hotel gas range, 30 feet in length, weighing several tons, and having an oven capacity equal to the roasting of 1,000 squabs at a filling.

Four huge plate-warmers, heated by gas, the apparatus being put up to taking care of 5,000 plates.

An automatic, instantaneous gas water heater outfit, up to an output of 600 gallons of water per hour, at a temperature of 160°. Gas heated coffee urns, capable of supplying coffee to 1,200 people. A gas heated hot water tank, 10 feet long, 4 feet wide and 10 inches deep, designed to accommodate many cylindrical copper vessels for keeping the soups at necessary temperature. Three great ventilating fans, 36 to 42 inches in diameter, with self-contained motors, made especially for the occasion by the Rochester Motor Company, and capable of displacing 50,000 cubic feet of air per minute, was installed with a view to keeping the building free of odor incident to the culinary operations. And there you have it.

The sequel to all this is that the kitchen responded satisfactorily to draught made upon it, not a hitch occurred anywhere, and the cooks, with their assistants, worked in a temperature and atmosphere that, in abetting their comfort, enabled them to do things up to the proper tune. To complete it all, and to show that perhaps the ubiquitous Manager of the Rochester Companies is expending some money in featuring gas in the "Flour City," the writer reserves for a finale the statement that the equipment of this kitchen, save in the instance

of the fans, which were gratuitously provided by the Rochester Motor Company, and the gas used therein in preparing for and keeping up the dishes of the feast, was given to the Chamber of Commerce with the compliments of the Rochester Railway and Light Company.

The Measurement of Light and Illumination.

[Communicated by a Resident of Highgate, London, England.]

The Illuminating Engineering Society in London, which held its inaugural meeting in November of last year, has already devoted several of its evenings to interesting discussions on somewhat original lines. Recognizing that, during its first year of existence, it would be well to devote its attention to increasing its circle of membership and stimulating public interest in the work of the Society, its members frequently have put aside evenings to general discussions, showing the width of the subject with which the Society has to deal. A special feature of the discussions already held has been the contribution of views from corresponding members of the Society, chiefly well-known authorities in different European countries and in the United States.

The first two meeting of the Society this year were given up to a discussion on "Glare," both engineers and physiologists participating. It soon became evident that there were too many points yet unsettled in connection with the subject for any immediate decisions to be arrived at, and it was eventually resolved to appoint a commission to inquire into the matter.

The third meeting of the Society, held March 15th, was notable for a discussion on "The Measurement of Light and Illumination." This, too, proved to require a second evening's discussion, even though it were only attempted to deal with the various points in a very general manner. In accordance with custom in these discussions the Society had prepared a list of queries which were circulated previous to the meeting. It was decided on the first evening to deal with those questions relating chiefly to the principles of light-measurement, leaving the more practical applications of the subject for a second discussion.

Photometrical experts were well represented, many of the best-known authorities taking part. Thus, Prof. A. G. Vernon-Harcourt, the inventor of the 10-candle power standard of light, gave his experience of tests in lighthouses, and Prof. Fleming, who has done a great deal of work in connection with standards of light, expressed his conviction that the standard of light of the future must be of an incandescent nature.

Another contribution to the discussion of considerable interest was that of Mr. A. P. Trotter, who spoke on the equipment of technical colleges, which he stigmatised as in many cases very unsatisfactory. It is rather curious that the technical institutions seem inclined to err in either one or another respect as regards photometric apparatus. Either they install needlessly complex and elaborate apparatus or they are contented with obsolete methods. It was also recognized by Dr. K. Stockhausen, of Dresden, who had sent a written contribution to the discussion, that the equipment of many technical colleges in Germany was not all that could be desired. In very few cases were they in a position to test *both* gas and electrical sources. However, he added that considerable improvement had already been made and he thought that things would be much better shortly. One modification in photometric measurements which, Mr. Trotter suggested, had not received the attention it deserved from those responsible for the arrangements for testing in technical institutions, was the plan of keeping the photometer still and moving one of the sources of light. In the case of gas flames, such as the pentane standard, this is not very convenient; but electrical glowlamps lend themselves specially well to the method.

Another respect in which, it was suggested, technical colleges were not up-to-date, was their backwardness in studying "integrating photometers," such as the Ulbricht globe. This apparatus, it will be recalled, consists of a large, hollow sphere, the interior of which is covered with some pure, white diffusing material. The source of light is inserted in the interior of the globe, and the light is reflected hither and thither on the inclosing white surface, the brilliancy of which thus comes to be a measure of the total mean spherical candle power of the source. The brightness of this surface is studied photometrically through a little window in the side of the globe.

Now, this apparatus is considered very convenient for the study of sources of light of a somewhat fluctuating character, for in such cases the readings are naturally very uncertain when it is necessary to obtain the polar curve of light distribution by a point-to-point method. For example, Prof. J. T. Morris, who spoke in this discussion, showed some diagrams illustrating how the candle power of many arc lamps was constantly fluctuating—he got over the difficulty to a great extent by the use of two mirrors at an angle of 180°. In addition it is, of course, very convenient to be able to obtain the mean spherical candle power by the aid of a single measurement.

It is, therefore, somewhat surprising that the use of apparatus of this kind has not received more attention in Great Britain. In Germany, where the globe photometer was developed, there are many such instruments in use, and a certain amount of work has been done on the subject in the United States. Dr. C. H. Sharp, for example, who contributed some remarks to the discussion dealing with this matter, has recently undertaken experiments in this direction.

A very interesting contribution to the discussion was, however, made by Dr. W. E. Sumpner, of the Birmingham Technical School, who explained a novel and ingenious method of treating the problem. In order to determine the mean spherical candle power of an arc lamp, he proceeds as follows: The arc lamp is placed at a certain height in a photometer room with blackened walls and serves to illuminate a long, vertical strip of white paper. The width of this strip varies according to its height, being so adjusted that the total amount of light reflected from the whole white strip is a measure of the mean spherical candle power; the proper shape for the sheet merely depends on the position of the source. The light reflected from the strip is then measured by a photometer.

Another matter, which received some attention from Mr. J. S. Dow and others, was the sensitiveness of photometers. Mr. Dow pointed out how the results of different observers had been expressed in very different ways in the past, and were not properly comparable one with another. One point deserving attention was that the best conditions of measurement depended on securing the right illumination of the photometer screen. When the illumination fell below 1 candle foot there was a distinct loss in sensitiveness; but above this value the sensitiveness of the eye to light and shade only increased very slowly.

A written communication, from Dr. K. Stockhausen, of Dresden, also dealt with this question. Dr. Stockhausen points out how influential is the physiological condition of the eye in causing differences in photometric sensitiveness. In darkness, for example, the eye undergoes a gradual adaptation to the changed conditions and its appreciation of light and shade becomes correspondingly acute. Certainly the exposure of the eye to a glaring source of light, even for a few instants, leads to a marked loss in accuracy and sensitiveness. Another matter which ought to receive attention from workers in photometry is the necessity of screening the eye from stray light, for such light produces a haze and makes the retinal image less sharp. A photometer should, therefore, always be provided with a suitable screen, rendering it impossible for the eyes of the observer to see the sources of light tested, or any other light of undesirable brightness. Here we see an instance of how the question of "glare"—the matter recently under discussion by the Society—also becomes of moment in connection with photometry.

It is, of course, impossible to do more than make very brief reference to a few of the points raised in this discussion, which is to be continued at a future meeting of the Society. The ground covered was exceedingly wide.

Another special feature of the meeting was the exhibition of photometrical apparatus. Thus, Messrs. Everett, Edgcumbe & Co. exhibited the most recent form of bench equipped with a flicker photometer, and flicker instruments of the Bechstein type (Messrs. Franz, Schmidt and Haensch) were also shown.

A very important and interesting feature was the opening of the discussion by the President, Prof. S. P. Thompson, who prefaced the discussion on more technical points by an explanation of the principles of photometry. His remarks were illustrated by demonstrations with large models of all the chief types of photometers.

Mr. A. P. Trotter also exhibited a series of small models of photometers for educational purposes.

Mr. J. S. Dow had an exhibit illustrating the qualities of red and blue light from the standpoint of acuteness of vision. A box was divided into two portions, illuminated respectively by blue light from a mercury vapor lamp screened with blue glass and red light from an electric glow lamp screened with ruby glass. When printed types, etc., were placed under these lights it was found that, notwithstanding the somewhat greater brightness of the blue, the detail

illuminated by the red light appeared much the sharper. It must be added, however, that this effect is not seen in the same way by everybody and depends to some extent on the peculiarities of the observer's eye. At a future meeting of the Society the discussion of the measurement of illumination and the more practical applications of the subject will be taken up.

The Blow Out Apparatus.

By "R."

The blow out apparatus of the boiler, tank, cistern, holder or other reservoir containing steam, air, gas or the like, should be used only for the purpose intended. In addition to the bottom blow out, the surface blow out is also useful. In a certain gas works visited by the writer a horizontal return tubular set of boilers was in use. The blow off pipe should have been at least 2½ inches in diameter. It was little less than 2 inches, consequently the capacity of the pipe was not enough when most needed, and an accident was narrowly avoided. Some of the blow off pipes are furnished with poor valves. Then there are valves which are not in good operating condition, due to clogged gearing, worn valve seats, bent parts or other retarding factors. There have been instances in which the blow off has failed to work, due to sand getting into the valve. I would examine the operating parts of the valve carefully quite often.

Some engineers favor the 2-valve system for all blow off pipes, for the reason that there may be something wrong with one valve just as you are closing it down. The defect may prevent the shutting off of the outlet and you might lose all of the steam if there is no second valve to fall back upon to shut off the pressure.

A good way to put in a blow off pipe is shown in Fig. 1. The lead from the interior of the wall can be furnished with a plug outside the wall, for the purpose of making a drain when the pipe gets clogged with sediment. Often the scale gathers in the square elbows, therefore, round ones are advised. A tee can be put in anywhere for tapping purposes, if desired. A tee with a cleaning plug is very useful. The regulation blow off valves will, of course, be employed, for any other kind will not give satisfactory results. When you get the drop right, a valve can be put in that too, which drop can terminate in the drain or to whatever it is desired to have the exhausted steam carried. In some places the blow off leads into pipes that carry the steam to points where the steam can be utilized to best advantage, instead of losing it entirely.

I have seen blow off pipes so arranged that the circulation is hindered. It will not do to have the water circulation interfered with; yet this happens quite often. The lack of effective circulation will render almost any system nil. Any sluggishness in the blow off will make itself felt in the system. Fig. 2 is an arrangement to give an effective circulation in cases in which the common plan will not answer the purpose. The blow off pipe is joined with the steam space. The additional pipe extends up in the rear of the boiler as shown, passing over to a connection with the steam space above. The necessary valves are put in for controlling purposes, as indicated.

In one plant I noticed that the engineer used the feed water pipe for a blow off. This method, of course, permits the cold water to strike the sheets where not intended, unless the feed is altered.

Fig. 3 presents a plan for the surface blow off. The floating, scummy impurity on the surface of the water in many boilers is very annoying, and compounds are put into the water to remove this foreign stuff, and there are patented contrivances to mechanically separate the matter and cast it off; but the engineer has his troubles with the same, regardless of the contrivances used for effecting a remedy of the evil. The steam bubbles often get interfered with and held flat, because of the weight of the stuff floating on the surface of the water in the boiler. Then, there are occasions on which a proportion of this stuff finds its way to the cylinders of the engine and trouble begins. Much of the mud-producing substance can be precipitated. The arrangement illustrated in Fig. 3 is one of many by which the troublesome material can be kept off from the boiler plates. A mouthlike, funnel-shaped piece is arranged near the surface of the water to skim off such floating impurities as the current of water makes its way towards the circulating pipe. A piece of flanged pipe is used for the settling chamber, this pipe being entered into the same to the depth needed to effect an entrance of about half the depth.

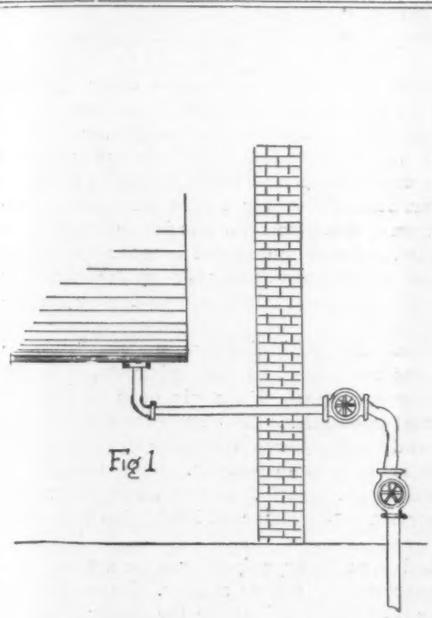


Fig 1

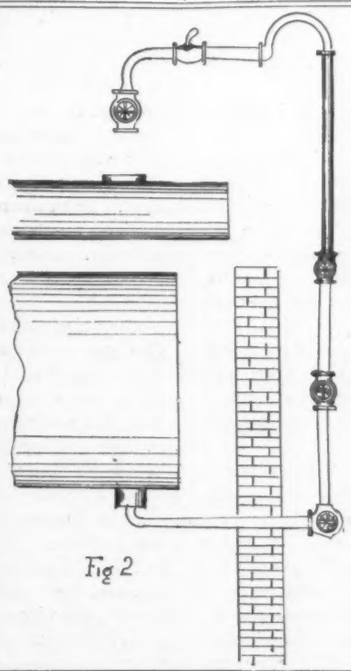


Fig 2

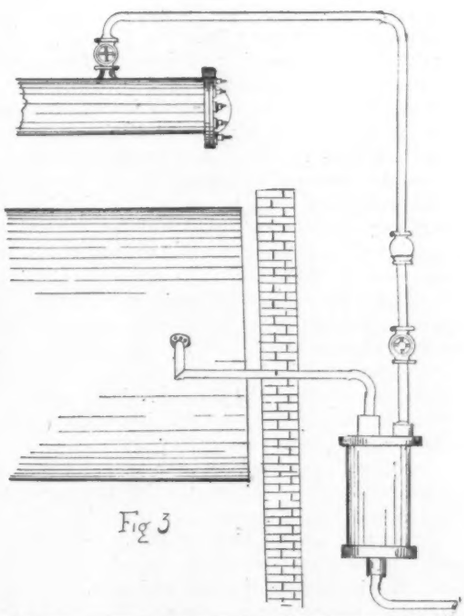


Fig 3

Some Remarks on Gas Compression.

[Prepared for the Fifth Meeting of the Natural Gas Association of America, by MR. H. R. DAVIS.]

On the average natural gas consumer the mention of gas compression has a peculiarly irritating effect. He has heard that the large compressing stations of the natural gas companies are maintained for the purpose of pumping air into the pipe lines, and whenever his gas bill exceeds his own modest estimate of what it should be he proclaims his belief. This rumor started when the first compressor station went into operation, and the truth has been trying to overtake it ever since, with small hope of success. The man in the natural gas business, not directly concerned with the transportation, knows that compression helps in some way to forward the gas from field to market. How, or why, he seldom stops to inquire.

The natural gas engineer recognizes in gas compression the solu-

tion of many of his difficulties. Incidentally, compression introduces problems of its own, not all of which have been fully solved. Without compression most if not all of the great natural gas enterprises would be impossible. Properly applied, compression increases the capacity of pipe lines many times, and makes practical enterprises which otherwise would require an investment so large as to be prohibitive.

Before going further it may be well to explain just what is meant by compression. The atmosphere exerts a pressure varying with the altitude, and averaging at sea level 14.72 pounds per square inch. For such rough calculations as may be needed here for illustration, 15 pounds per square inch will be considered as one atmosphere. This pressure of the atmosphere must be borne in mind. Men often forget it in discussing gas pressure. Even experienced engineers sometimes expose themselves to ridicule by neglecting it in their calculations.

Natural gas, like air or any other gas, occupies a space inversely proportional to the pressure upon it. That is, if we have 10 cubic feet of gas at atmospheric pressure, under 2 atmospheres, or 15 pounds gauge pressure, the same gas will occupy only 5 cubic feet. Under 10 atmospheres, or 135 pounds gauge pressure, the space occupied by the gas will be reduced $\frac{1}{10}$ of the original volume. In the above illustration we are assuming the temperature of the gas to remain constant. Since, then, putting the gas under pressure so greatly reduces its volume, it is clear that the higher the pressure at which we carry the gas the greater the volume which a pipe line will contain. That raising the pressure will increase the capacity of the line to convey gas may not be so apparent at first glance. It is a fact, however, that the capacity of a gas pipe line increases with the initial pressure and at a faster rate.

Natural gas compressing stations may be divided into 3 general classes, according to the nature of their work.

As an example of the first class, we will suppose a field which has been supplying gas to a market 100 miles distant through a 16-inch line. Originally, this field had a rock pressure sufficient to maintain an initial pressure of 300 pounds on the line. Assuming that a terminal pressure of 50 pounds must be maintained and using the usual formula for calculating the flow of gas, the line under consideration is capable of delivering about 35 million cubic feet of gas per day. If the pressure of the field falls, until it can maintain an initial pressure of only 200 pounds, the capacity of the line is reduced to 23 million cubic feet per day. In order to get the original capacity with the reduced pressure, it will be necessary to duplicate the original line for about $\frac{3}{4}$ of its length, or 75 miles. There is the further certainty that even this will shortly be inadequate.

Now, let us see how compression will help us. A compressing station, with power to compress to 300 pounds from any intake pressure, and with capacity, so long as the intake remains above 100 pounds, to handle all the gas the line can carry can be installed for about 15 per cent. of the cost of a new line. This figure is only approximate and varies with every case. The greater the distance from field to market, the greater is the advantage of compression compared with installing an additional line. The proper balancing of the sizes of compressor station and line, so as to obtain maximum capacity with minimum cost, is one of the most important problems which the natural gas engineer is called upon to solve.

The second application of gas compression is found in relay or intermediate stations. Considering again our problem of the 16-inch line, 100 miles long, we will assume that the consumption of gas increases beyond the line's capacity of 35 million feet per day. The problem now is, shall we duplicate part of the line or install a compressor station about midway between the terminals? It is evident to all that, other conditions remaining the same, a short pipe line will deliver more gas than a long one. Placing a compressor station near the middle of our pipe line has the effect of making it necessary for the field station to deliver gas to a point 50 miles away. Here the new station will pick it up and forward it the remaining distance. This practically reducing the length of the line by half adds to its capacity about 35 per cent. The ratio between the costs of the compressing station and the pipe line necessary to give an equal increase in capacity is less in this instance than in that first considered; but the balance is still strongly in favor of compression. Beyond this point the ratio diminishes rapidly, and, with the pressure now used on most trunk lines, it is not economical to place compressing stations much nearer to each other than 50 miles. The maximum pressure which the system is designed to carry determines the economical distance between stations. The present trend seems to be in the direction of continually increasing pressures. The high pressures make possible the use of smaller pipes and reduce the number of compressing stations necessary on long lines.

The third application of gas compression might perhaps be included in the first class considered. It is the use of small compressing stations to render available isolated gas pools of low pressure at some distance from the main line. Were the gas from such a field allowed to flow to the main line compressors, with only the field pressure behind it, the low intake pressure would effect a reduction in the capacity of each compressor, and the number of compressors required would be correspondingly increased. A small compressing station at the field will usually show a marked economy, as compared with the large main line compressors and enlarged field pipe lines which must otherwise be used. Besides this, these local compressing stations increase the output of a field so greatly as often to pay for their erection inside of a year by this increase alone.

The distinctive feature of the compression of gas is the variable intake. In air compression the intake pressure is almost always the pressure of the atmosphere, which is practically constant. In handling natural gas, any one of 100 causes may affect the flow of gas in such a way as to make the intake pressure vary within wide limits. The capacity of any compressor, or the number of cubic feet pumped by it per minute, is directly proportional to the intake. That is, a compressor which will deliver 1,000 cubic feet of gas per minute with an intake of 1 atmosphere will deliver 2,000 cubic feet per minute with an intake of 2 atmospheres, and so on. It is evident then that, as the pressure of any field declines, the capacity of the station supplied by this field must be correspondingly increased to maintain a uniform delivery to the line. The power required to drive a gas compressor also varies with the intake, the discharge pressure being constant. However, the relation is not so simple as the one given above, for it is evident that if the intake and discharge pressures are the same no power will be exerted. Also, if there is an absolute vacuum at the intake there will be no compression and consequently no power required. Then the power must increase for a time as the intake pressure rises, reach a maximum, and then grow less for any increase of the intake. Theoretically, this maximum point is reached when the intake pressure is .325 of the discharge. In practice, the maximum power is usually required with a rather higher intake than that obtained by calculation.

The principles which I have outlined above are now taken for granted by all natural gas engineers. In the laying out of a new natural gas system every movement of the gas, from well to consumer, is a matter of exact calculation. The sizes of the pipes and the capacities and spacing of the compressor stations are all proportional to the work they will be called upon to perform. Being able thus to proceed with absolute assurance, we are liable to forget how recent are the beginnings of our art, and what a bold innovation it was but a few years ago.

In 1890, Pittsburgh had been using natural gas for a number of years, and the field pressures were falling rapidly. Many and various were the plans brought forward to increase the supply of gas to the city. One man, still known to the engineering profession, advised that large steel tanks should be taken to the gas fields, filled with gas at well pressure, hauled by rail to the city and connected to the pipe lines, where they could give off the pressure they had obtained at the wells. Other engineers, among them George Westinghouse, saw no way out of the dilemma except by increasing the capacity of the pipe lines, and this was the plan pursued by the Philadelphia Company.

Mr. J. N. Pew, then President of the Peoples Natural Gas Company, conceived the idea of handling natural gas by means of pumps. To him, undoubtedly, is due the credit for introducing compressing stations into the natural gas business. His success was not achieved without overcoming opposition and discouragement. Several of the prominent pneumatic engineers considered the plan of very doubtful practicability. Others declared it absolutely impossible. About this time Mr. Pew met Mr. Greenwood and Mr. Gerdes, of the Hall Steam Pump Company, and it was from these gentlemen that he received his first encouragement. They believed his scheme to be practical and so advised him. To settle the question without undue expense, they suggested that a small experimental plant be built. This appealed to Mr. Pew, and experiments were at once begun to determine whether natural gas could be successfully handled by means of compressors.

A 10-inch by 12-inch oil field engine, of the Mogul type, was purchased, the back head removed, and a gas cylinder, 6 inches in diameter by 12-inch stroke, was attached to the engine. This machine was installed at Wilkinsburg, and there a small pipe system was designed and built and experiments carried on for a month or so. The result

was a complete justification of the theories of the builders. Mr. Pew immediately placed an order with the Hall Company for the first commercial gas compressing station. This was located at the Murraysville field and delivered gas to Pittsburgh. It consisted of a duplex 24-inch by 30-inch Stearn's slide valve engine, attached to the rear of which were two Hall 20-inch by 30-inch gas compressor cylinders.

After less than a year's operation, orders were placed by the same Company for two more machines for the same field. At the very outset, Mr. Pew fully grasped the essential principles of pumping gas, and immediately obtained a patent on a system, which included a large receptacle placed near the compres sing station and attached to the pipes coming from the field, thus gaining a large volume of gas at the compressor and insuring a uniform flow in the pipe line. He was unable, however, to secure a patent of such a scope as to prevent his plan being followed by others. Indeed, the success attending Mr. Pew's efforts was soon appreciated by his competitors and a number of stations similar to his were installed in the different fields.

The Philadelphia Company installed, near Cannonsburg, 2 cross-compound engines, of the Porter-Allen valve type. As an effort toward the economical production of power their move was commendable. Unfortunately, they had little conception of the gas compressing problem, so they decided that a gas compressor could be built exactly like a blowing engine, and accordingly built the machine with mechanically operated, sliding inlet valves. Furthermore, the gas cylinders was built for compound compression. As designed, these engines were a failure. Later the gas cylinders were replaced by Hall, single-stage, poppet valve compressors, and for the past 10 years they have been in successful operation.

This brings us up to the year 1900, in which year the Carnegie (Pa.) Gas Company, and the Fort Wayne (Ind.) Gas Company, installed stations aggregating in each case about 3,000-horse power. These stations were built along the lines of modern steam engine practice, with cross-compound condensing Corliss engines, water tube boilers, and all the auxiliaries necessary for the economical use of fuel and steam. It is worthy of note that these stations were a remarkable step forward in the practice of gas compression. The compressor used on these engines was practically the equal of the best gas compressor in use to-day. Modifications of the design used here have, of course, been made, but they have been to meet different conditions and do not constitute material improvements.

Since 1900, all the large natural gas companies have been forced to the use of compressing stations. Up to 1904 to 1905 most of the stations were driven by steam engines. However, prior to that time there were a few natural gas managers, more courageous than the rest, who turned to the gas engine as the power best suited to the work. The first successful direct-connected gas engine driven compressor was built (1899) by the National Transit Company, of Oil City, Pa., from the designs of their engineer, Mr. Klein. Two cranks were placed at opposite ends of the same shaft and set at an angle of 90° to each other. One of these cranks was driven by 4 single-acting power cylinders. From the other crank were driven 4 compressor cylinders. The 90° angle between the cranks allowed the maximum point of power stroke and maximum of compression to come nearer together. Eight or 10 of these engines were built later by the Snow Steam Pump Works and most of them are in successful operation to-day.

The first gas engine-driven compressor of the present type, having the compressing cylinders opposed to the power cylinders, was built about 1902 or 1903 for the Logan Natural Gas and Fuel Company and installed at Sugar Grove, O. It was a 400-horse power engine with 36-inch stroke. It gave fair satisfaction in spite of some faults in the design. These faults were afterwards corrected and the machine is giving excellent service to-day. Shortly following this first engine the Snow Company undertook the construction of two 4,500-horse power engines for the Hope Natural Gas Company and installed them at Hastings, W. Va.

This brings us to the present standard, twin-tandem, double-acting gas engine gas compressor, of about 1,100-horse power, so many of which have been installed in Ohio, Indiana, West Virginia and Kansas. This engine has been perfected to a degree which gives little prospect of any material improvement or change in design. When working at its maximum load of 3 compressions, it uses for fuel about 2 per cent. of the gas pumped, an economy which cannot be approached by any other power. In point of reliability, it shows itself equal to any demand put upon it for hard and continuous service.

The use of gas compression appears to be far from having reached its full development. The falling pressure in the older gas fields is continually causing the building of new compressing plants, and there is little doubt the near future will witness large gas compressor installations for the exploitation of fields hitherto unutilized.

Care and Installation of Regulators.

[Prepared for the Fifth Meeting, Natural Gas Association of America, by Mr. M. G. Reynolds.]

As this paper has been assigned to me I will endeavor to give it what thought my limited time will permit, and trust, by giving you some of my observations and experiences as a manufacturer of regulators, it will assist in improving the service given.

To secure good regulation the regulator should have the best conditions possible, as the best machine cannot do good work if any water, obstructions (and especially if any hard particles) collect in the valve and seat. In laying mains each joint should be cleaned separately, and before connection is made to the regulator the line should be blown out to clear it of loose scales and hard particles. During the first year's service of screwed pipe, scales will become detached and are carried along with the gas. If a screen is used at the inlet and the gas is not clean these scales soon clog and prevent a free flow, but if a large cylinder is installed ahead of the regulator and the current slowed up these particles drop and will not get into the regulator. We have known of such carelessness in laying pipes as to find a piece of a fence rail left in the pipe, another where a squirrel had made its nest and storehouse in the pipe before it was laid, and which consisted of a half bushel of leaves and 20 nuts, which were found in a regulator that was reported as not doing its work satisfactorily. These, of course, are extreme cases, but we have so often found that, where the regulator failed to properly regulate, especially on the minimum supply, it was almost invariably caused by some hard substance finding its way to the valve and stopping between the valve and the valve seat. If it is a scale of iron and the valve closes on it, the tight-closing valve is destroyed; the pressure creeps up on the minimum consumption and, of course, it increases until the safety valve blows and prevents further raise of pressure, but causes much waste of gas. If a regulator of a proper size could always be installed to supply the peak load with the valve well open, it would allow all small particles to pass through and out of the way. The large volume flowing through the pipes moves the scales and dirt, so if the regulator is of large capacity, and the valve is only slightly opened, it is much more liable to stop the scale in the valve and cause bad regulation. So we think it best to consider well the size of piping, the pressure to be reduced and the size of the low pressure main to be supplied at the reduced pressure, then install a regulator large enough to deliver the volume easily. The pressure on the high side has much to do with the installation, as the volume contained in a given space is about doubled in raising the pressure from 4 ounces to 15 pounds. The valve capacity of a regulator should be equal to the area of the line, so that, should the pressure drop to near the discharge pressure the regulator will not retard the passage of gas when the high pressure is at its minimum. If a uniform pressure could be maintained in the high pressure line of say 20 pounds, a regulator could easily supply a much larger low pressure main. With the latest improvements we have known a 12-inch low pressure main being supplied by a 4-inch regulator. This could not be accomplished with the pressure the same on both sides of the regulators—it must have the differential in pressures. If there is a question of supply to a certain point, as there always is where gas is transported through long pipe lines, we do not think it advisable to install mains and regulators of a much larger capacity than are needed to handle the maximum volume that can be delivered at that point, as further expense is a waste of funds and may not give as good results when the higher pressure is maintained. In the installation of reducing stations on a pipe line it is advisable to install the regulators in duplicate, so that in case of any repairs or cleaning is needed the opposite regulator can take care of the supply. But if a single regulator is used, then a by-pass around the regulator should be installed to be used in case the regulator needs repairing, and in this condition, with a gauge on the low side, the by-pass valve can be gradually opened until it supplies the volume required, which will be indicated by a slight raise in the pressure and closing of the regulator. Then the valve at the inlet of the regulator must be closed

tight, after which close the outlet valve, then the regulator can receive the needed attention, and while the regulator is being repaired observe the gauge and manipulate the by-pass valve to suit the pressure needed. When the work is completed always open the low pressure valve first, then the high pressure valve, which puts the regulator in action; next gradually close the by-pass valve. When installing low pressure regulators at different points through a city plant we do not think it necessary to use a by-pass at all, but would connect the regulator between the high and low pressure mains, using a gate valve on both sides of the regulator, so that, if necessary, it can be cut out of commission and the necessary volume will come from other stations for the short time the regulator is out.

With clean, dry gas the regulator seldom requires any attention, but it is advisable to visit them occasionally. The office gauge will quickly indicate an error if anything goes wrong at the station. The first regulator that was installed at Iola, Kas., was set within a few feet of the well. Three years later I called on the gas company and, with their superintendent, went out to see this regulator. He informed me he had not given the regulator any attention whatever during the 3 years, excepting to shift the weight to change from summer to winter pressure. Being anxious to see its condition inside we took it apart and found the valve and diaphragm in perfect condition. This regulator was reducing their well pressure direct to low pressure of 8 and 16 ounces. We think it advisable to examine all stations twice each year (spring and fall), and if they do not close tight, or the diaphragm shows the slightest leakage, take them apart and thoroughly clean the inside, especially the valve and valve seat. When these are cleaned, put the valve back in place and turn it around several times while it is in contact with the seat, then remove the valve and you will readily note where they have come together, for a bright line shows where the two metals came in contact. If it does not show a complete contact on both parts re-grinding is necessary. Flower of emery, or pumice stone and oil, may be used for grinding these metal valves, using a little grinder where the metal shows a contact. Put the valve in place, give it a few turns, remove and clean it off, and note the results. Continue grinding the high places until the valve fits perfectly, this properly done the regulator should do as good work as when new. If the regulator has a stuffing box and gland, this packing will need some attention, as it is very liable to harden and require a very tight gland, which would cause much friction and a greater variation in the low pressure mains. A diaphragm made of a good grade of rubber should last for several years, if the regulator is kept in proper working order, but must be renewed if damaged.

Regulators intended for natural gas were all constructed so that they received the controlling power from the low pressure mains, which has given very good satisfaction; but with the advent of high pressure artificial gas, which is now being pumped as high as 40 and 50 pounds, it was necessary to improve on regulators so as to hold the required inches in the water column, a variation of not more than 2-tenths was required and secured. This was accomplished by using the low pressure, and to this was added a part of the high pressure through an auxiliary system which made it possible to secure any amount of power necessary to hold a perfectly steady pressure in the street mains regardless of the volume needed. The improvements made in the various sizes and makes of regulators in the past few years have revolutionized the distribution of both natural and artificial gases throughout the entire world.

The Conservation of Natural Gas.

[Prepared for the Sixth Meeting of the Natural Gas Association of America, by Mr. J. C. McDowell.]

Conservation of our natural resources is a subject of national interest and general discussion at the present time. The importance of this subject to the gas industry is very great, for no other one of the Earth's treasures has been so wantonly wasted as natural gas. The elusive nature of this product necessitates unusual care to prevent waste; but I speak particularly of the careless, willful, preventable waste that has been going on with accelerated pace for more than a generation. Its magnitude is appalling, and it is both fitting and timely that this Association took advantage of the present general interest in conservation and, if possible, reduce theoretical to practical conservation, by crystallizing public sentiment into laws that will effectually prevent all unnecessary waste of natural gas.

Deposits of natural gas are more generally or widely distributed than any other mineral product of the United States. It is found in nearly every rock porous enough to contain it. It is closely associated with petroleum, and the production of oil is nearly, if not always, accompanied by the production of gas in some quantity, from the same well, at the same time. However, gas deposits cover a much greater area than oil deposits, extensive areas of gas bearing strata being developed in which no petroleum is found. While natural gas is so universally existent in the earth, its profitable commercial exploitation requires that it be found in a rock stratum entirely incased within an impervious stratum of shale, and that it is not accompanied by oil in paying quantities, or salt water in great volume. Up to this time five great regions have been discovered and developed within the United States and Canada. The principal deposit in each of these regions is found in a different geological period from the others. In the order of their discovery and utilization they are as follows:

The Appalachian Region.—Extending from the southern counties of Western New York, along the west flank of the Appalachian Mountain System, through Pennsylvania, Southeastern Ohio, West Virginia into Kentucky. Within this region the deposits are found, principally in the rocks of the Devonian Period, and in many different strata, varying in depth from a few hundred feet to 3,600 feet, and there is little doubt of deposits in still lower strata. Until very recently it was thought that the limit of profitable production had been reached in these deep wells, but a recently invented drilling bit by the rotary method will, in the opinion of the writer, make it possible to drill to a depth of 5,000 or 6,000 feet. Only those who have closely watched field developments can fully appreciate the importance of this invention to our industry.

The Trenton Rock Region.—It extends from the north shore of Lake Erie, in the Province of Ontario, Canada, in a southwesterly direction, through Northwestern Ohio and the State of Indiana. The gas deposit of this region was confined to one formation—the Trenton rock of the Lower Silurian period—geologically the oldest deposit yet discovered. There was but one producing stratum in this region, it being near the top of the rock. The existence of oil and large quantities of salt water in the same rock with the gas was a very unfavorable feature of this deposit, tending to shorten the life of the field, which, on account of the depth of the wells, had a low initial rock pressure.

The Clinton Rock Region.—Extending from the Province of Ontario, Canada, on the north shore of Lake Erie, through Central Ohio, to the southern counties of that State. The deposit of this region is found principally in the Clinton Formation of the Upper Silurian Age, at a depth of from 1,000 to 3,000 feet; geologically it lies between the Trenton rock of the Trenton region and the Devonian of the Appalachian region. No oil in profitable quantities, and no salt water of sufficient volume to interfere with the production of gas have been found in this formation.

The Mid-Continent Region.—Extends from near Kansas City, in a southerly direction, through Kansas and well toward the southern counties of Oklahoma. The deposit throughout this region, is found in irregular sand formations of the Carboniferous Period, at a depth of from 400 to 2,000 feet. Many of the developed sands produce petroleum in very large quantities and gas in great volume from the same wells. Other sands of the same region produce gas in very large volume, free from oil, and comparatively free from salt water.

The Caddo Region.—This is a comparatively new region, having at present a developed area of about 300 square miles. Four distinct sands, in the Tertiary Formation, each of unusual thickness, have been penetrated by the drill at from 800 to 2,300 feet in depth, resulting in wells of enormous volume, 40 to 70 millions feet open flow capacity being not unusual. The field is not yet defined in any direction, and the probabilities are that its present area will be greatly enlarged.

Other regions in the United States are in the incipient stages of development. Our Nation seems to have had almost a monopoly of this precious fuel treasure—its value probably exceeding all of the vast deposits of coal, of which we love to boast. Stored under great pressure, released by the drill at will, it carries itself to markets far distant from its source, and is supplied to domestic consumers at a cost very much less than any other fuel has ever been, or can be produced by them, and has become a source of great convenience, comfort and increased happiness to millions of our people because of its convenience and cleanliness.

The zones of natural gas supply have become zones of industrial activity and increased population. The wealth of the State and its

revenues derived from taxation on account of such increased population and the various interests fostered and supported by natural gas have been largely increased. States, counties and municipalities have, at great expense, equipped State houses, asylums, hospitals, court houses and other public institutions. If the supply is carefully husbanded and protected it will last for a great many years and continue to furnish abundant fuel, and the population, material, wealth and other interests of the State will be benefited and enhanced and the comfort, enjoyment and happiness of the people greatly increased; consequently, its conservation is a matter of great concern to the general public as well as to the thousands of stockholders who have invested over $300,000,000 in the industry, and to investors in business enterprises affiliated with and dependent upon the natural gas industry.

The development and operation of every region above mentioned have been and now are continuous records of reckless and wanton waste. It is difficult to estimate, and more difficult to appreciate, the enormity of the waste of this cheapest and best fuel known to civilization. Its escape and loss are accompanied with so little demonstration that they attract but slight attention from the public.

If within the borders of the State of Oklahoma a pile of 10,000 tons of mined coal was being wilfully burned, wasted, every day by its owners, a special session of the Legislature would be called to consider means to prevent the loss, and regardless of existing laws, guarding private ownership, a way would be found to stop it and a court ready to sustain the action. Yet at the present time heat value and money value, in volume of natural gas, greater than 10,000 tons of coal, are daily escaping into the air and lost, 80 per cent. of which is easily preventable.

The history of every oil pool in Oklahoma is a sickening story of waste of gas, the latest of which is "Hamilton Switch" or "Preston." There is no doubt that the fuel value of natural gas wasted in the production of oil in Oklahoma in the past 5 years has been of vastly more value than all the oil produced.

The same terrible waste has been going on, and now exists, in the new Caddo district in Louisiana and the people look on, seemingly unmoved. From recent personal inspection and inquiry into conditions in the Caddo field, I am convinced that not less than 400 millions cubic feet of gas is escaping and wasted daily in that field, hava fuel value of more than 20,000 tons of coal—practically all of the waste being preventable. Would the good people of Louisiana stand idly by for several years and see a pile of 20,000 tons of coal uselessly consumed by fire every day and take no action to prevent it? I think not.

The citizens of West Virginia have for more than 10 years been indifferently watching an equivalent of from 10,000 to 30,000 tons of coal, in natural gas wasted daily, and there seems to be only one man in that State who raises his voice to prevent it, and although Prof. I. C. White, State Geologist, has cried aloud and spared not in trying to stop it, his efforts have been unavailing and the pile of coal continues to burn. This appalling daily dead loss to the general community is unnecessary, and the utter indifference of the public to this awful waste seems inexplicable, unless it is from the fact that what is out of sight is frequently out of mind. The principal avenues of waste at present are:

1. In drilling for oil in some districts large gas wells are found in sands above the oil sands. In many instances the pressure and the volume of such wells are so great as to prevent drilling to the lower oil bearing sand until the well has been allowed to exhaust its gas production into the air, sufficient to permit the resumption of drilling. Usually this criminal waste is allowed to continue until the gas bearing sand is nearly, if not quite, exhausted.

2. Many gas producing sands are entirely free from oil, while gas in varying quantities is always found in oil bearing sands. All flowing oil wells are also gas wells of more or less volume. It is not uncommon to find an oil well producing 50 to 100 barrels of oil, also producing from 5 to 10 million feet of gas per day, the gas, at a low rate, being 4 or 5 times the value of the oil.

3. Leaking gas lines; open flambeau; blowing off gas wells.

4. Wasteful methods of utilization.

The oil producer in his insane greed for riches, fortified by the long established custom, is the principal transgressor. Having no immediate market for the gas of the upper sands, he allows it to exhaust itself in the air until the pressure is reduced to a point where he can resume drilling; then he penetrates the oil sand where he may and frequently does develop a well producing from 5 to 10 barrels of oil and from 5 to 10 million cubic feet of gas, the latter having a fuel value at a very low figure per 1,000 of many times the value of the oil. In nearly every new oil development the oil wells produce gas from the oil sand in considerable quantities. The oil producer, if in need of power, uses what gas he requires for power purposes and turns the balance loose, looking on any surplus gas as a nuisance to be gotten rid of, claiming the right to do as he pleases with his own product; and, in the absence of legislation on the subject, he seems to be acting within his rights.

Through the third avenue mentioned the principal waste is from unnecessarily blowing off wells. There are certain districts where the traveler can scarcely get out of the hearing of gas wells being blown off. Most of this is entirely unnecessary and should be prevented. The loss through wasteful methods of utilization is gradually diminishing, although many millions of cubic feet are wasted daily by flat rate sales without meters and by imperfect devices for burning. It is a matter for serious consideration when from 40 to 60 cubic feet of gas per horse power hour is used under a boiler for driving a steam engine, while the same power can be developed by the consumption of from 9 to 15 cubic feet per hour in a gas engine of equal reliability and cost of maintenance.

Under our form of government a national conservation law to prevent waste of gas would be of no avail, except on United States government land, all of the present production being on lands held by private ownership within the States. They cannot be reached by Federal law on this subject; consequently, if the waste can be prevented by law, it remains for the State to enact laws for that purpose. And, since the oil producer does not seem to appreciate the value of the gas he wastes, he should be restrained by law if possible.

It must be admitted there is a seeming unfairness in preventing a man from operating oil wells on his own farm, because he cannot market the gas they produce, while his neighbor on an adjoining farm who has a gas line to a city may continue to operate his oil wells because he has a market for his gas. But public policy often interferes with so-called private rights.

The Trenton Rock field, in Indiana, was discovered in 1886, and that immense field was practically exhausted in 20 years. I think it is conservative to say that 3 times as much gas was wasted in that region as was profitably used. When, in the year of 1898, the people realized the existing riot of waste was rapidly depleting their valuable reservoir of choice fuel, they effectually prevented any further useless waste of gas in the field by enacting a law declared to be constitutional by the Supreme Court of the United States, in a strong opinion by Justice White, which said to the oil producer: "You cannot produce oil until you provide means to separate and utilize the accompanying gas." And it also said to the producer and consumer of gas that it was against public policy to waste gas, and prohibited all waste by either party, providing severe penalties for violation of the act. Though enacted too late to conserve the Indiana supply, the law was rigidly enforced.

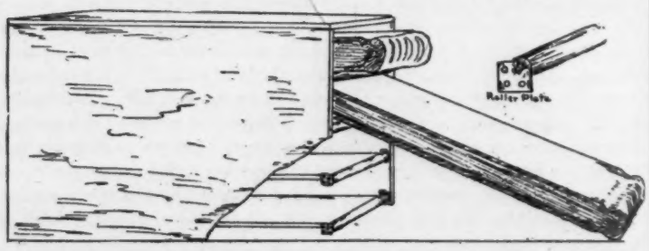
The present laws of Kansas, Oklahoma and Louisiana do not reach the oil producer, and in consequence are of little value for conservation. The statute of Indiana for the conservation of oil and natural gas should be enacted into law in every State where oil and gas are produced. It will be opposed by some oil producers and large oil corporations; they will assert that they cannot produce oil and save the gas; that their individual rights are being trampled on, etc., etc. In a recent conversation on the subject, the manager of one of the largest oil companies operating in Indiana said to the writer that he approved of the Indiana law for the prevention of waste of gas; that he had experienced no great difficulty in operating oil wells in Indiana under that law, and that no oil producer ought to object to the passage and enforcement of such a law. The writer can point to a large number of wells where oil and gas are both being produced from the same well, the gas being separated from the oil and delivered into large mains at high pressure by means of compressors.

It is the duty of every member of this Association to join with the good citizens of the community in which he resides, who cannot be open to the charge of self-interest, to insist that the Legislature of his State enact efficient laws to prevent the waste of natural gas. Use the press and the platform. Agitate the question until its importance is realized and public opinion demands and secures the conservation of natural gas."

MR. H. M. BYLLESBY, head of the firm of H. M. Byllesby & Co., of Chicago, has been elected a Director in the Chicago, Milwaukee and Puget Sound Railway Company.

A Rack for Gas Ledgers.

At the recent meeting of the Natural Gas Association of America, the wrinkle budget proved quite a feature, and in the collection was one submitted by Mr. F. W. Stone, of Ashtabula, O., a gentleman who is quite as well known in the artificial gas field as he is in the natural gas section—and wide and favorably known he is in both. His contribution bears No. 9 in the wrinkle budget, and it had to do with a rack for gas ledgers in instances where more than one ledger is being handled by the bookkeeper. As shown in the illustration



the rack is divided into shelves with just sufficient space between them to admit the placing of a gas ledger. A roller is placed in front of each shelf, with its top projecting from ¼ inch to ½ inch above the shelf. The end of the ledger is put on the roller and the ledger is pushed into position, the roller carrying the weight of the ledger, thus allowing it to very easily slide into place. This obviates the necessity of lifting one book over another, and any ledger is instantly available.

Average and Maximum Loads of Electric Light and Power Stations.

Mr. Alton D. Adams, in a contribution on this subject to the *Electrical World*, remarks: During 6 months of each year the loads of electric light and power stations do not usually go above ¼ of the December maximum. For the entire year the station load equals ¼ of its maximum during no more than $\frac{1}{10}$ of the time in some instances. The absolute maximum load is probably not carried 50 hours per year at most central stations.

As a result of these conditions, energy outputs are generally less than ¼ what they would be if electric stations operated continuously at the maximum load of the year. These facts are illustrated by the records of capacities, maximum loads and average outputs of a score of electric light and power stations for a recent year presented herewith. It is evident that facts like those disclosed in these records have important bearing on the type of generating equipment best suited to electric stations, the costs of operation, the capacity for additional loads at certain times of day and year, and on rate schedules that are intended to vary with the cost of rendering the service.

It is thus a question whether engine equipment that has to operate only from 1 to 5 or 10 per cent. of the total number of hours per year should be of the most efficient type with the increase of investment that this involves. There is some point where high efficiency during short hours of operation is more than offset by the greater charge for interest, depreciation and repairs. For stations that work with average 24-hour loads that are only about ¼ of the yearly maximum, much remains to be done in the way of electric heating, the charging of storage batteries to displace engines in isolated plants, and even in the operation of electrochemical processes, as well as in the increase of motor loads. If electric rates are to vary with the cost of rendering the service, it is of interest to know how a consumer who contributes to the short hours of nearly maximum load is to escape the highest rate for energy received at such times.

Coming to the electric supply systems under consideration, the data concerning them are arranged in the accompanying table, according to the number of kilowatts in the average 24-hour load. This average is obtained by a division of 8,760, the number of hours per year, into the total number of kilowatt-hours generated. Besides the average load, the maximum load of the year, the percentage of the average to this maximum, and the kilowatts of generator capacity are given for each plant. Though the tabulation covers a wide range, from the average load of 10,374 kilowatts down to only 66 kilowatts, there is a striking approach to uniformity in most of the percentages of average to maximum loads.

No definite variation of the percentage of average to maximum load is to be noted with the size of plant, and it happens that both the lowest and the highest percentages are found among the stations of rather small outputs. The general force of these percentages is to show that the annual outputs generated by the electric stations are equivalent to continuous operation at ¼ to ½ of the maximum loads. The selected stations cover a range of maximum load from 36,324 kilowatts down to 224 kilowatts, and so represent the character of the demands on electric supply systems from great cities to small towns. The generator capacities in these electric systems run from 61,400 kilowatts in the largest down to 222 kilowatts in the least.

Maximum and Average Loads.

Kw. Average Load.	Kw. Maximum Load.	Per Cent. Average to Maximum.	Kw. Generator Capacity.	Ratio Generator Capacity to Max. Load.
10,374	36,324	28.5	61,400	1.7
1,893	5,693	33.2	9,625	1.7
1,146	3,492	32.7	4,900	1.4
1,004	3,350	30.0	5,290	1.6
740	2,735	27.0	4,700	1.7
668	2,510	26.6	4,505	1.8
538	1,650	32.6	3,650	2.2
482	1,850	26.0	2,500	1.3
457	1,510	30.2	2,000	1.3
424	1,675	25.3	2,300	1.3
354	1,245	28.4	2,700	2.1
336	1,325	25.3	2,100	1.6
291	980	29.7	1,570	1.6
244	1,100	22.1	1,839	1.6
219	710	30.8	2,300	3.2
149	523	28.4	600	1.1
135	650	20.7	1,195	1.8
125	500	25.0	725	1.4
75	224	33.6	222	1.0
66	308	21.4	340	1.1

Wide differences will be noted in the proportions of generator capacities to maximum loads. In more than ½ of the systems, however, the capacities of the generators were 1.3 to 1.7 times the maximum loads. These varying ratios for generator capacities must be attributed to additions of new equipment as well as to the requirements for reliability and for inductive alternating loads.

Water power was used to generate important parts of the outputs in the system that had an average load of 1,893 kw. and in that with 336 kw., while water power did most of the work for the average load of 75 kw. These three systems show percentages of 33.2, 25.3 and 33.6, respectively, for the ratios of the average to maximum loads. As two of the percentages last named are the largest in the list they appear to confirm the general impression that the use of water power tends to develop a high load factor. In this connection, however, it may be noted that in many instances water power has merely served to develop a large motor load without much addition of electric heating and residence lighting. Where this has been the result the load factor may have changed but little with a large increase of average load, unless the use of motors is so restricted that the power load is not added to the lighting peak on winter days.

In the supply system where the load factor was only 25.3 per cent., in spite of the extensive use of water power, more than ½ of the total output was sold to an electric railway, and nearly twice as much of the remaining energy was sold for stationary motive power as for lamps. With these railway and motor loads added to the lighting peak a high power factor could not be expected.

At the plant with the load factor of 33.6 no energy was sold to electric railways, and the sales of energy for motors amounted to 1.6 times the sales for lamps. The load factor of 33.2 per cent. for the next to the largest system in the group is of especial interest from the fact that the generating capacity of the water power, though only about ½ as great as that of the steam power equipment, was utilized to develop a large lighting as well as a large power output. In spite of its connected load of more than 6,000-horse power in motors, this system sold more energy for light than for power during the year. The equivalent lighting load in this system was about 130,000 lamps of 16-candle power each. Great varieties of manufactures were carried on in the service area of this electric system, that of machinery being the leader, but these manufacturers were not mainly of the sort that request the largest amounts of power.

What can be done by an electric system having steam for its only source of power in a city of heavy manufacturing loads is shown by the load factor of 32.7 per cent. with the average load of 1,146 kw.

In this instance the combined rating of connected motors was over 6,000-horse power and the lighting load was equivalent to about 80,000 lamps of 16-candle power, but the sale of energy for power was nearly twice as great as the sale for light. Textile industries were the great users of energy in the city served by this electric system, and motors connected with the public supply did a good share of the work.

The load factor of 32.6 per cent. with the average of 538 kilowatts was secured by the combination of large street and residence lighting and motor loads in a territory where there was comparatively little store lighting. In this system more than ¼ of the total output was devoted to street lighting, and with more than 1,200-horse power of connected motors the lighting load exceeded the equipment of 90,000 16-candle power lamps.

Quite a different situation in the system with 22.1 per cent. load factor and 244 kilowatts average illustrates the proposition that a large motor load when unrestricted as to time may do very little to decrease the relative importance of the lighting peak. This system had motors connected to a combined rating of more than 1,600-horse power and sold about twice as much energy for motors as for lighting, but still its load factor was near the lowest in the list. Evidently something besides 10-hour motor service is required to even up the load curves of central stations.

For the metropolitan system, where short-hour lighting is in great demand, with its average load of 10,374 kw., perhaps the most notable fact is that a load factor of 28.5 per cent. was obtained with only about 12 per cent. of the total output devoted to street lighting, and with the equivalent of nearly one million 16-candle power lamps and more than 44,000-horse power of motors connected.

The Direct Measurement of the Total Light Emitted from a Lamp.

[Prepared by W. E. SUMPNER, D.Sc., M.I.E.E., for the April Meeting of the Illuminating Engineering Society, London, England.]

The quantity of light emitted by any form of lamp is measured by its spherical candle power. The determination of this quantity is of commercial importance, and a simple method of making the test is much wanted. The best known direct test is by the use of the Ulbricht globe.

This globe no doubt yields good results in practice, but it has some defects which prevent its action from being quite accurate. It is the purpose of this paper briefly to allude to these sources of error, and in particular to discuss whether it is possible to obtain equally good or better results by using, in place of the globe, merely a rectangular box.

The accuracy of the action of the globe is dependent on at least four assumptions. In the first place, the inner surface must reflect light of all colors equally well, and the reflecting power should be high. There is no difficulty about this, but if the surface were not quite white the error due to selective color action would be most serious, quite apart from any difficulty of color photometry. In the next place it is assumed that there are no surfaces within the globe which absorb or reflect light. This cannot be quite true in practice. The small surface used to screen the direct rays of the lamp from the photometer window causes some error, though in most cases this error may be negligibly small. But when arc lamps possessing globes are under test the error may be quite appreciable. Such arc lamp globes are usually suspended near the top of the Ulbricht globe, and their action tends to prevent the upward rays of the lamp from having their proper influence on the photometric measurement. A third assumption which is well understood is that the surface of the Ulbricht globe reflects light by diffusion only. It must be a matt surface and not shine by regularly reflected light. Such a surface is easy to procure. But a fourth assumption, which I do not think has been previously discussed, refers to the material of the window transmitting light to the photometer. It is assumed that this window transmits light by diffusion only, that is, it is assumed that none of the rays pass straight through it as would be the case with transparent glass. The material used for this window must be most carefully chosen, for unfortunately any translucent substance like milky glass transmits light partly by diffusion and partly by direct transparency, and it may quite easily happen that the amount of light leaving the sphere through the photometer window is quite as much due to transparency as to diffused transmission. In such a case the effect on the photometer measurement would be serious. Part of the light received from the window would follow the law assumed in the theory of the Ulbricht globe, and would be due to the light falling on the window from all parts of the sphere. But another, and possibly equally important, portion would follow a different law, and would be due to the brightness of the part of the opposite surface of the sphere, visible from the photometer through the (transparent) window.

These properties of translucent materials I investigated, together with a number of kindred matters, in a paper[1] read in 1892 before the Physical Society. I must refer to this paper for proof of the foregoing statement, and also for the proof (given on page 84) of a theorem, about a sphere, which I quote below. Its discovery rather surprised me at the time. It forms the basis of the action of the Ulbricht globe suggested some years afterwards. The theorem was thus stated:

"If any complete (or if any portion of a) spherical surface be illuminated in *any* manner, I_o, by the *direct* rays of a combination of light sources, the actual illumination, I, will exceed I_o by a constant amount all over the sphere, owing to the reflective action of the surface."

This theorem is remarkable for two things—for the ease with which it can be proved and for its extreme generality. It does not matter how uneven the candle power of the light is or where it is placed. It need not be at the center. There may, indeed, be any number of lamps placed anywhere within the sphere. It does not matter what the reflecting power of the surface is, or how the reflecting power may vary from part to part. In particular a portion of the surface may have zero reflecting power, which is equivalent to the removal of that part of the surface, and this portion may be of any shape we please, though, of course, the amount of this increase will depend on the particular circumstances of the case. The theorem results from a more elementary one, which may be stated thus: *Any bright patch on the inner surface of a sphere illuminates each part of the spherical surface to the same extent.*

Now the brightness B of any part of the surface is related to its illumination I, by a simple formula involving ρ, the reflecting power of the portion of the surface considered. The formula is:

$$\pi B = \rho I,$$

each of these expressions representing the total light sent out by the surface per unit area. If we denote by the suffix zero the values of the corresponding quantities, assuming no increase due to internal reflection, we have also

$$\pi B_o = \rho I_o.$$

Now by the above theorem we know that for a sphere I exceeds I_o by the same amount for every part of the surface. B will not exceed B_o by a constant amount unless ρ is the same everywhere, but the excess of B above B_o will always be proportional to ρ. In the case of the Ulbricht globe the surface is all of the same reflecting power, so ρ is constant, but it entirely depends on the value of ρ whether one can regard the surface as being equally bright everywhere or not. It is now well known that for a complete inclosure (of any shape), whose walls have a reflecting power ρ, the average actual illumination I is related to the average initial illumination I_o, due to the direct rays of the light sources by the formula:

$$I = \frac{I_o}{1-\rho}$$

$$\text{or, } I = I_o + \rho I;$$

so that the constant increase of illumination above referred to is ρ times the mean illumination. A similar formula applies to B. Now if ρ is only 10 per cent., B is essentially the same as B_o, and varies to the same extent, but if ρ is 90 per cent., B is on the whole 10 times as large as B_o, and consists of a small portion B_o, which varies from one part of the surface to another, together with a portion about 9 times as large, which is constant. With the surfaces actually used in an Ulbricht globe the value of ρ is probably about 80 per cent., which means that the constant proportion of B is 80 per cent. of the average value of B, the rest is B_o, due to the direct action of the lamp's rays, and varies with the candle power in the corresponding direction. With such a high value of ρ the error of the measurement yielded by the globe is probably not serious. But there would be a great error if ρ were small and the photometer window partially transparent. B would then be simply B_o, due to the direct rays of the light, and part of the illumination at the photometer would depend on the mode of distribution of B_o as well as on its average value. I tried experimentally some years ago to arrange a surface of white paper in

1. The Diffusion of Light, *Phil. Mag.*, 1893.

reference to an arc lamp and a photometer, and so to shape the paper that the light reflected by it into the photometer would be a measure of the mean candle power of the arc. This is possible, because the shape of the paper required is independent of the law of distribution of the light from the arc. But, though possible, this method proved inconvenient and is not to be recommended. All I need say about it here is that the surface required must intercept rays inclined at angles to the axis of the lamp. This is not true of the patch of reflecting surface used with the Ulbricht globe, for that part of the light which is transmitted to the photometer straight through the photometer window when this is partially transparent. This globe can only give good results if ρ is large and if the photometer window is perfectly diffusive.

Since the Ulbricht globe does not act with mathematical accuracy, I have considered the simpler case of a rectangular box surrounding the lamp and lined with a good white reflecting surface, such as white paper or white enamelled iron. Investigation shows that there is not any simple accurate formula connecting I with I_o in the case of a rectangular box, as there is in the case of a sphere. But if the reflecting power of the surface is high the brightness will tend to become uniform all over the surface, and I find that *whatever the shape* of the surface is we can assume as a *first* approximation that the brightness of the surface is constant, we have as a *second* approximation:

$$I = I_o + \rho I_m \text{ and } B = B_o + \rho B_m$$

or for *every portion* of the surface I exceeds I_o by a constant amount equal to ρ times the average illumination, the same as for a sphere. (This follows from equations 1 and 4 of the paper already referred to.) Now, this second approximation must be very close indeed to the truth in the case of a nearly cubical inclosure with highly reflecting surfaces, for it is a matter of common experience that the white surfaces of walls or ceiling in ordinary rooms, so far as the eye can judge—and the eye is the only possible judge—are of the same brightness everywhere, however the lights may be arranged—except in so far as shadows on the walls or ceiling may be cast by objects in the room or by projections from the ceiling, etc. That is to say, the variation of I is mainly due to I_o. Moreover, the equation is certainly true in the average, for, as already stated, the averages of I and I_o must differ by ρI_m.

Now, suppose the light to be tested is placed at the center of a cubical wooden box whose inner surfaces are white and have a reflecting power of about 80 per cent. Let the length of each side be one yard and let the box rest on some horizontal surface. Suppose on one of the vertical sides a hole is cut of dimensions 2 inches by 1 inch, and that into this hole is fitted one end of a rectangular wooden tube 8 inches long, the other end being closed by one of a pair of blocks constituting a Joly photometer. The tube is assumed to be horizontal and to be at right angles to the surface of the box. For the present we assume that the tube is open at the end fitted to the box, and not closed by a glass window, as in the case of the Ulbricht globe. The illumination falling on the inner Joly block can be balanced by that due to a comparison lamp of K candle power placed at a distance D feet from the outer block along the line of the tube. When the balance is obtained by adjusting D we shall have:

$$\frac{K}{D^2} = B\phi$$

Where B is the mean brightness of the surface of the cube to which the tube is exposed, and Φ is the solid angle subtended by an area of 2 square inches at a distance of 8 inches, *i. e.*, $\phi = 2/64$. It will be readily seen that the dimensions of the patch, on the opposite face of the cube, effective in illuminating the inner Joly block at its center, will be 10½ inches by 5½ inches, and its area about 55 square inches. A short calculation will show that the above dimensions are suitable. For suppose the light within the cube is that of an arc lamp whose mean spherical candle power is 300. The light in lumens given out by the arc will be 4π times 300, or 3,770 lumens. Owing to the internal reflection this will be increased in the ratio $1 - \rho$ to I where ρ is the reflecting power 0.8; or the total light falling on the sides of the cube will be $5 \times 3{,}770 = 118{,}850$ lumens. The area of the sides is 6 yards, or 54 square feet, so that the average illumination I_m in lumens per square foot (or in candle feet) will be 349 candle feet. The mean brightness B^m is obtained from this by multiplying by ρ and dividing by π, or the mean value of B is 89 (in candle power per square foot in the direction normal to the bright surface). Since Φ as just shown is 1/32 it follows from the above equation that the illumination at the surface of the inner Joly block is 2.78 candle feet and will correspond with quite a convenient balancing distance D if the comparison lamp K has the candle power of an ordinary glow lamp.

To calibrate the apparatus it will be necessary to put a light of known mean spherical candle power within the cube, as in the case of the Ulbricht globe. The mean candle power of any light used with the cube will then be inversely proportional to the square of the balancing distance D. The only assumption made is that the brightness of the patch of surface used by the photometer is always proportional to the mean candle power of the light within the cube. As already stated, this assumption is accurate enough providing the reflecting power ρ is sufficiently high. There still remains the question of the best position for the photometer tube. It should be so placed that it does not point to any part of the arc lamp. This is easily arranged, because the area of the patch of surface used is small, less than half a square foot in a side having an area of 9 square feet. The part of the surface chosen should not be that where the rays from the arc are strongest, or where they are weakest. We have:

$$B = B_o + \rho B_m$$

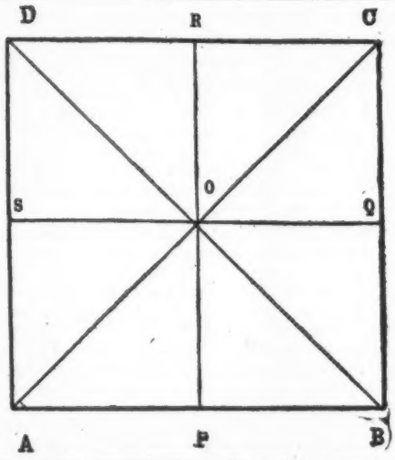
where B_o is always small compared with the total. All we want for *perfect* accuracy is to have the value of B_o/B_m the same for the patch or surface chosen, whether we test a light of uneven candle power like an arc lamp, or calibrate the sphere by a light of fairly uniform candle power, such as a Fleming standard glow lamp. This end is essentially secured if we choose a portion of the surface the direct illumination of which due to an arc lamp is about the average value due to that lpmp. For arc lamp testing the photometer tube is probably best placed on the middle horizontal line of one of the vertical faces of the box and a few inches in from one of the vertical edges.

As regards the reflecting surface of the wooden box this can be simply secured by the use of whitewash or white paper, presenting a matt diffusing surface such as is assumed in the foregoing argument. But a certain amount of regular reflection would not be any disadvantage, so that the surfaces might be of white paint or white enamelled iron. It is easy to see that the regularly reflected rays will, in the case of a rectangular box, be successively reflected at different parts of the surface, and will tend to produce the desired uniform illumination. The aperture of the illuminated inclosure can be closed by a diffusing translucent surface suitably screened from direct rays, just as in the case of the Ulbricht globe. Whether the extra complication would result in increased accuracy can only be determined by thorough testing.

There is an entirely different way of using a rectangular box for the present purpose. The theory of this method depends simply on the principle of symmetry. There are few if any commercial forms of lamp the light from which is not distributed symmetrically about an axis. Suppose the rectangular box is resting with two of its surfaces horizontal, and that the light is placed at the center of the box with its axis vertical. It is then obvious that there are four vertical planes through the axis, each of which divides the surface of the box into 2 halves, and that on each of these halves the total light received is the same. If $A\ B\ C\ D$ is a horizontal section of the box, and O represents the axis, the four planes in question are represented by the two diagonals and by the two central lines parallel to the sides. The light received by the portion of the surface consisting of the vertical strip $A\ P$, and the two horizontal triangles $A\ O\ P$, will always be a fixed fraction of the total light emitted by the lamp, and in the case of a box of square section this fraction will be $1/8\ (1 - \rho)$ or 5/8 if ρ is 80 per cent.

Now suppose the box is formed of wood, and that its internal surfaces are well whitewashed. Suppose the part of the box represented by AOP is cut out, and that in its place is fixed a framework supporting three surfaces replacing the missing portions of the box. Let these surfaces consist of a substance transmitting and diffusing light such as opal glass or engineers' tracing cloth. The light received by these new surfaces will still be a fixed fraction of the total light emitted by the lamp, and this will also be true of the amount of light diffused outwards. All that remains to do is to arrange some suitable way of illuminating a photometer by this outwardly diffused light. This object can be attained by the use of two good mirrors, one touching the top and the other the bottom of the box along an edge parallel to SO. Each mirror should be inclined 45° to the surface of the box so as to reflect the light from each triangular area AOP along the line OP. The photometer should be placed along the line OP produced, and from its position the appearance will be that of 3 flat bright surfaces each perpendicular to the line of the photometer. If the box is a yard cube the size of these surfaces will

be considerable, and the photometer distances will have to be large for accuracy. This will be no novelty in arc lamp testing since the intensity of the light necessitates large photometer distances. For glow-lamp testing the dimensions of the cube can be made much smaller as well as those of the rest of the apparatus.



A little consideration will show that the inclosing box need not be shaped like a cube as indicated in the above figure. Thus, O might be the apex of a pyramid of which $A\ B\ C\ D$ is the rectangular base, this pyramid standing on a similar but inverted pyramid with its apex at O' vertically under O. If the light to be tested is placed within these surfaces, with its axis along OO', it follows from symmetry that the two triangular areas AOP and $AO'P$ will together receive $\frac{1}{4}$ part of the light. These surfaces will be equally inclined to any line drawn from the center through a point on the edge AB. If the photometer be placed along any such line, if the areas AOP, $AO'P$ consist of translucent diffusing material, and if the other areas have an inner surface of high reflecting power, it follows from what has been previously said that the photometer will measure the total output of the lamp. No mirrors will be needed as in the former case, because all parts of the surface are equally inclined to the photometer line. It will also be apparent that instead of two pyramids we might use two circular cones in the same way. $A\ B\ C\ D$ would then be a circle instead of a square, and for the translucent part of the surface we could choose the portion between any two planes through the axis. This latter arrangement seems the simplest of all.

In conclusion, a word or two about units. It will be a pity if the Illuminating Engineering Society help to perpetuate the use of such a cumbrous expression as mean spherical candle power. This quantity no doubt represents the output of light from the source, but its value can only be obtained by first of all measuring the output itself, and it is of no use except as a measure of this output. In connection with electrical theory Oliver Heaviside has declaimed at the irrationality of estimating the output of a source by a flux it produces at a distance. It is still more irrational when the source, as in the case of light, is of such a nature that we have to imagine an artificial mathematical concept styled a "Mean Spherical" flux existing no one knows where.

In the case of electricity the rationalizing of the units is now difficult if not impossible. The international units are already fixed. In the case of light this is not yet the case, in spite of all the congresses whose deliberations have left the subject in its present unsatisfactory state. It is to be hoped in the case of light that "rational" units will in the end be adopted, and that the unit of light will refer to the total output of the source, and not to its candle power in any real or imaginary direction.

The difficulties connected with the subject may possibly make it necessary to retain, as a concrete standard of light, one having a fixed candle power in some specified direction, but it is not necessary to continue the use of the phrase mean spherical candle power. In practice the makers of both glow lamps and arc lamps consistently specify light sources in terms of their maximum candle power. From this the total light emitted can be obtained by multiplying by some factor, and it is this factor which is wanted rather than the mean spherical candle power. For glow lamps the maximum candle power is at right angles to the filament, the mean candle power is obtained from this maximum by multiplying by a number which, as Prof. Fleming showed some years ago, is always close to the theoretical value $\pi/4$. The total light in lumens is got from this by multiplying by 4π, so that, in the case of glow lamps, the light in lumens is theoretically π^2 times, or approximately 10 times the maximum candle power. In the case of arc lamps the light in lumens is roughly 4 times the maximum candle power. It seems desirable to discard the expression mean spherical candle power and to specify lights (1) by the commercial measure, *i. e.*, the maximum candle power, and (2) by the "lumen-factor" which when multiplied by the above value gives the output of the light in lumens.

Advertising.

[Read by Mr. T. R. Elcock, at the last meeting of the National Commercial Gas Association.]

This paper will not suggest unusual schemes to excite interest in our product, nor will it disclose any rare or heretofore unheard of plan to double the consumption in a year; it will treat only of how best to adapt our regular facilities to a campaign for new business. What it advises is little more than salesmanship moulded to publicity partaking of the nature of salesmanship.

Advertising to sell gas means more than merely familiarizing the public with the name, description and price of your goods. You must talk, argue and convince. We cannot be guided by wonderfully successful campaigns with which we become familiar through our daily papers and periodicals, campaigns costing vast sums of money and designed to reach every reading person in the country. In the first place, very few of us have *vast sums* to appropriate for advertising; and, in the second place, such advertising would do us little good. Of course, it may occur that some day will see an enormous consolidation of all the gas companies in the country, in the interest of advertising, and a national campaign carried on, but until then the manager of one town will not relish the idea of buying space in magazines and periodicals that will be just as effective in scores of other towns as in his own.

Each of us, looking at the narrow confines of his own territory, sees but one effective method of general publicity—the daily newspaper. A majority of us, I think, are somewhat skeptical in regard to the wisdom of investing in newspaper space. The skeptics, I fear, are those who feel somewhat alike about all advertising, and their opinion in a way is justified, for they have attempted to trace results to that which is only advertising in name. In some situations newspaper advertising is being splendidly done, and undoubtedly valuable results are being obtained. In this field of advertising we must be guided to a great extent by the present trend of the reading public towards advertising in general. To-day nearly as much attention is given to the advertising part of a public print as to the news or reading section, and advertisements are being read seriously and their statements relied upon.

We have advanced a little beyond the age when to say, "Cook with Gas" was sufficient to sell appliances. We have already reached the consumer who would buy an appliance upon such little argument. Of course, continued publicity, keeping the slogan, "Cook with Gas," before the public has its effect; but we are not content with this. We want to reach out in our field, gathering in the hard heads and the doubters, showing them they *must* use gas or live a life of trials and extravagance. Upon this theory, then, we must go into our newspapers with good, forceful copy, we must argue and convince, we must invade the home secrets of the holdbacks and picture to or impress upon their imagination the changed conditions possible if they use gas, without giving the impression that our chief argument is economy, show that money can actually be saved and how it can be saved. We cannot blindly follow or be influenced by the wonderful selling of some article due to mere display advertising. The word "Uneeda" sold many crackers. "See that Hump" made women swarm to the notion counter, but such articles cost 5 or 10 cents. Few of our appliances cost less than $10, possibly the majority that we wish to sell cost between $10 and $15, or from $15 to $20. It takes argument to make a man hand over a $10 bill; he wants to know what he is getting and why he is getting it. We cannot play upon a sudden resolution, a passing whim; people will often buy an article for 10 cents out of mere curiosity, but a man has to be remarkably curious to spend $10 on it. He has to be convinced.

In a situation where direct advertising is done to any extent, it is

not so important to use the daily papers, describing and giving prices of appliances and lights. In such cases the newspaper can most effectively be used for publicity. This does not necessarily mean that we must inflict upon the public a great mass of figures, showing costs, profits, stocks, bonds, etc.; possibly a small per cent. of the public would be interested in such, and even they would not be convinced. What our customers like to hear, however, is what we are doing to improve their service. We can make such a message actually instructive and full of news interest. Few of us realize how ignorant the average citizen is in regard to gas. How it is made, how distributed, the unceasing care in its manufacture, the eternal vigilance necessary to keep it to a certain quality and pressure, are sealed books to the vast majority. The consumer's idea of a gas company goes little beyond the meter, the meter reader and a place to pay bills; they have used gas for a long time, doubtless all their lives, and they regard it as an inseparable part of their existence. Anything we tell them of what we are doing to improve their service will be read and appreciated, and friends will be made who will be in more receptive mood for your direct advertising designed to actually sell your goods.

In such advertising, however, we gain an excellent chance to reach the dissatisfied consumer and to gain leads to follow to the appliance out of use. We can call on our consumers to test our assertions of *good service*, to let us know of any lamp or appliance not giving satisfaction, and to form the habit of notifying us when anything of any description is wrong. In this we make a very strong first step towards increasing the consumption on appliances already installed, often a very perplexing problem. It is not necessarily difficult to write such copy; design your advertisement so that it is instantly apparent who is talking, give a straightforward account of what you wish to make public and rely on being believed. Do not be afraid of making any assertion that you are sure of too strong. If you are not sure of it, don't write it.

Many of us approach the writing of an advertisement with a feeling of fear, primarily for the reason that we cannot think of anything bright enough. If we can readily think of some wonderfully bright headline, some rare play on words, or a topical hit laboriously molded to fit our subject, we think our success all but attained. It is well to remember the many failures due to freak advertising, advertising that advertises the ad., not the goods. Good, strong copy is the kind that impresses the reader with the effectiveness of the appliance advertised and seems to fit their own particular case. Transport yourself into the mental attitude of the person you address. Picture to yourself what they would most desire to know about your appliance, the strong points that would give them a desire to purchase and to convince them it is the very thing they want.

Few of us will doubt the efficacy of direct advertising. This really is salesmanship, a personal contact between the company and the consumer. For this kind of advertising we are most fortunate if the card index system is maintained, a record of every house in your entire field. Aside from its other excellent uses for advertising such a system is invaluable. It provides the finest possible kind of mailing list and enables us to reach each consumer with a message both timely and appropriate to conditions. If it is properly kept, it is possible to work hand-in-hand with the selling force, to reinforce the personal call by advertising matter and to reinforce the advertising by the personal call. In the event of no card index being used, similar results may be obtained, in a small situation, by using the ledgers as a basis for a mailing list; but this is not satisfactory, for the reason that conditions are not instantly apparent and you lose the valuable connection of interest with the selling force. Having your mailing list directly before you, it becomes a comparatively easy task to individualize your advertising. The personal letter is undoubtedly valuable. The more personal the better. Do not have this letter a mere statement by the corporation—have it an actual letter from some real person to the consumer. In a small situation the signature of the manager or superintendent is effective—in a large city have the signer a man the consumer can actually reach, the district agent or head salesman stationed at their nearest office. The card index provides all manner of excuses for these letters. The non-consumer, the user of fuel only, the unpiped house, receives letters; the applicant for gas receives a letter on appliances, the buyer of a gas range gets a water heater letter, the large houses are sent automatic water heater letters, the stores lighting letters, the factories letters on lighting and industrial gas, and the well equipped address receives a letter on their gas service and inquiries as to their complete satisfaction in their use of gas. In every letter, no matter what the subject, inclose a return postal. If your salesmen are following these letters closely, you may not get a great many postals back, but what you do receive are worth getting and mean something. Be satisfied if you can check up from 1 to 2 per cent. returned. Remember the consumption of gas on one appliance pays for a great many letters. By improved writing appliances, these letters can be made such a true imitation of an original typewritten letter that an expert cannot discern the difference. Have them addressed at the head of the letter by a typewriter and the signature in ink. A direct campaign can be considerably enlivened by good, well printed and designed mailing pieces. Such forms are used to illustrate the appliance or lamp and may be used to follow or precede the letter or call of the salesman, to familiarize the consumer with the appearance of the article or as a price list to allow opportunity for a choice. Let the gas company issue these. Some of us, for economy sake, use the forms supplied by the manufacturers of appliances. In some instances these are very good, but they usually lack the personal quality peculiarly necessary in direct advertising.

What you attempt in any phase of advertising, do well. A cheap looking advertisement will tend to cheapen the opinion of your goods. It is part of your display and will be considered as such. Give thought to your show rooms; if you lay out a model kitchen, make it a model; do not be satisfied to have a gas range stand upon a piece of linoleum and depend upon the public's imagination to supply the rest of the scene. Use your show windows as a storekeeper would. They are meant for advertising. Design their display as you would an ad. Change them frequently, have the subject timely and confine it to exploiting a certain thing. Just as in writing an ad., endeavor to first arrest the attention of the passerby, draw a mental picture of how the appliance or lamp would appear in their home, and in a few words on a printed sign give some newsy, interesting data, and let them know the selling price.

Advertising, in whatever phase you consider it, should be governed by good common sense. Endeavor to look at it through the eyes of your consumer and you cannot go very far wrong.

Gas Meter Testing in Manchester, England.

Mr. S. Dyson, Official Inspector of Gas Meters in Manchester, in his seventeenth annual report respecting the work done in the year ended March 31st, furnishes the following particulars:

The number of meters tested was 41,997, showing an increase of 3,438 compared with the previous year. The fees received amounted to $8,350; being an increase of $670. The amount expended on equipment for the year was $225, and this, together with the ordinary expenditure of $10,165, makes a total of $10,390. There were 1,786 meters rejected, or 4.25 per cent. Of the total wet meters tested—viz., 9,278—253, or 2.71 per cent., were rejected, and of 32,719 dry meters tested, 1,533, or 4.68 per cent., were rejected. The number of meters rejected increased from 509 to 1,786, compared with the previous year, or from 3.30 to 4.25 per cent. This was owing to a number of old meters being tested which had been in use for a good many years.

For the last 8 years the "index test" has been applied, with satisfactory results, to all meters belonging to the Corporation. There are no statutory powers for this test, and it was on the recommendation of the Justices' Testing Committee that it was instituted—the Manchester Corporation consenting to pay an additional fee, so that all their meters should have the indices tested, for the protection of the gas consumers. Several gas companies and corporations also send meters to be tested, stipulating that the "index test" shall be applied. During the past year 13,304 dry meter and 5,266 wet meter indices were tested, and 56 of them were rejected as incorrect, from the causes shown in the following table:

Upright shaft out of action with drum shaft	9
Incorrect number of teeth in index wheels	5
Defective front plates and inaccurate marking	21
Damaged fittings and wheels	5
Index wheels out of action	9
Incorrect gearing	2
Indices transposed	5

The most serious cases of error were found in 5 meters, particulars of which are appended. The first 3 had been repaired by the manufacturers, and before being put into use again were submitted for testing, while the other 2—viz., the 10 and 50-light meters—were both owned by the consumers and had been in use on their premises.

5-light,	registering	100	per cent.	fast.
3 "	"	50	"	slow.
5 "	"	25	"	fast.
10 "	"	150	"	"
50 "	"	150	"	"

Mr Dyson says it is important to mention that all the above meters were found correct when tested by the dial, which is in accordance with the provisions of the Sale of Gas Act, 1859, and the only test in general use throughout the country, except in Manchester and Liverpool. He points out that no general charge of carelessness can be attributed to an inspector for stamping such meters under the limited test of the measuring chambers. The defect is attributed rather to the state of the law, and the absence of compulsory powers as to the full testing of the indices or registering apparatus as well as the measuring chambers of gas meters.

The Manchester Corporation during the past year submitted for

testing 1,449 meters, which had been in use for 10 years and upwards, nearly all of them being owned by the consumers; and 356 of the number were found correct and 1,093, or 75.4 per cent., incorrect.

Bureau of Information, The American Gas Institute.

Under the direction of the Institute it has been decreed: 1. That the privilege of submitting questions be limited to members of the Institute. 2. Neither the Board of Directors of this Institute, nor the Institute as a body, make themselves in any way responsible for the statements of fact or expressions of view given out by the Bureau of Information.

BUREAU OF INFORMATION, THE AMERICAN GAS INSTITUTE,
HEADQUARTERS, GAS OFFICE BUILDING,
V. F. DEWEY, Chairman. DETROIT, MICH., May 23, 1910.

Question No. 61.—"What is the best accepted method of checking Orsat analysis results?"

ANSWER TO QUESTION NO. 61.

The simplest and most conclusive check is to run a duplicate sample on a Hempel apparatus for exact gas analysis. An Orsat apparatus is not adapted to very accurate work. Error is due to the form of the apparatus, difficulties of manipulation, and the trying circumstances under which it is used.—Submitted by F. E. PARK, Supt., Station "B" Plant, Detroit City Gas Company.

Question No. 62.—(a) "What is the easiest method of checking the carbon oxide elements of a gas against a total which is about 34½ per cent.?" ($X \times CO + Y \times CO_2 = 34.5$ per cent.)

(b) "What values should be given X and Y?"

Answer.—In general, a formula based on the CO and CO_2 content of a flue or producer gas is of little value in checking the analysis for accuracy. So many disturbing factors enter into a problem of this kind that it is impossible to develop a formula that shall be generally applicable.

In producer or flue gas there may exist three general types of combustible gases, more or less completely burned:

1. Straight producer gas, the product of incomplete combustion of dry air and dry carbon.
2. Blue water gas, from the moisture in the air and fuel.
3. Coal gas, from the volatile part of the fuel.

If the last two types are absent, an analysis may be easily checked from consideration of the composition of the pure unburned producer gas:

$$2C + O_2 = 2CO$$
(1 vol.) (2 vols.)

The 20.8 per cent. of oxygen in the air doubles in volume in forming carbon monoxide. Hence pure unburned producer gas has 34.44 per cent. CO:

$$100\left(\frac{2 \times 20.8}{120.8}\right) = 34.44 \text{ per cent.}$$

Then, if the burned gas and excess air are eliminated from circulation, the analysis may be considered accurate in the degree in which the CO content of the remaining pure producer gas approaches 34.4 per cent. If no CO is present the CO_2 and O_2 should, of course, be 20.8 per cent.

It is the last two types of gas—the blue water gas formed from the moisture in the fuel and air, and the coal gas formed from the volatile part of the coal—which introduce variables, interfering with the operation of any formula that might be devised. It is evident that the amount of burned or unburned coal gas coming from the volatile part of the fuel cannot be determined by analysis, and its effect on the analysis estimated, since coal gas is variable in composition and the water formed in combustion condenses out. Therefore, the only possibility of checking an analysis depends upon the assumption that the amount of volatile matter in the fuel is too low to have any appreciable effect.

The second disturbing factor (the formation of blue water gas) could be allowed for if it were not for the impossibility of knowing at what temperature the reactions take place. Moisture reacts with incandescent carbon as follows, depending on the temperature:

Above 1,800° F.: $H_2O + C = H_2 + CO$
Below 1,800° F.: $2H_2O + C = 2H_2 + CO_2$

Eighteen hundred degrees F. is about the temperature at which carbon dioxide is appreciably decomposed by incandescent carbon. As there is no way of telling in what proportion these reactions take place, an analysis showing hydrogen cannot be checked.

In case no hydrogen is found the problem is greatly simplified, since no permanent effect can be caused by decomposition of water, if the hydrogen is burned back to water again before the analysis is taken. The water acts simply as a carrier of oxygen, and the resulting gas is identical with the products of combustion of dry carbon and dry air.

A formula for checking the analysis of gas from the combustion of dry carbon and dry air would then be applicable to any flue or producer gas, providing no hydrogen were found in the analysis, and that the amount of volatile matter in the fuel were inappreciable. If dry carbon is burned with dry air the following equations take place, considering the combustion to take place in two stages:

(1) $2C + O_2 = 2CO$
(1 vol.) (2 vols.)
(2) $2CO + O_2 = 2CO_2$
(2 vols. + 1 vol. = 2 vols.)

If just sufficient air is admitted to form CO, the resulting gas will contain 34.44 per cent. CO, as previously noted. Equation (2) shows that there is no change in volume of the carbon oxide when CO burns to CO_2. Every volume of CO forms an equal volume of CO_2, but the oxygen disappears. Hence the per cent. of the carbon oxides would remain constant on burning, without excess of air, if it were not for the dilution with nitrogen.

For every volume of CO burned, half a volume of oxygen disappears (equation 2), and the resulting gas is diluted with $\frac{3.808}{2} =$ 1.904 volumes of nitrogen, where 3.808 is the ratio between nitrogen and oxygen in the air:

$$\frac{79.2}{20.8} = 3.808$$

As every volume of CO burned is represented by an equal volume of CO_2, every per cent. of CO_2 represents 1.904 per cent. of nitrogen of "dilution." Subtracting 1.904 per cent. for every per cent. CO_2, from the original volume considered in figuring the analysis, the per cent. of combined oxides will remain constant at 34.44 per cent., if the analysis is correct.

Let x = per cent. CO, y = per cent. CO_2, and z = per cent. O_2,—then,

$$\frac{x + y}{(1 - .01904\ y)\ (1 - .04808\ z)} = 34.44 \text{ per cent.}$$

(4.808 = ratio of air to oxygen in the air.)

$$\frac{100}{20.8} = 4.808$$

The second factor below the line eliminates excess air from the calculation.

The following analysis given in Mr. Chas. D. Lamson's paper on "A Pound of Coal" (AMERICAN GAS LIGHT JOURNAL, p. 341, 1910; "Progressive Age," April 15th, 1910, p. 329; "Proceedings American Gas Institute," Vol. 4, p. 352), illustrates the operation of the formula:

Oxide Flue.

CO_2	10.0	per cent.
O_2	0.4	"
CO	18.7	"
N_2	70.9	"
	100.0	"

$$\frac{18.7 + 10}{(1 - .01904 \times 10)\ (1 - .04808 \times .4)} = 36.14 \text{ per cent.}$$

instead of the theoretical 34.44 per cent.

A producer gas analysis in the same paper gives the following result:

CO_2	3.7	per cent.
O_2	0.0	"
CO	28.5	"
N_2	67.8	"
	100.0	"

$$\frac{28.5 + 3.7}{(1 - .01904 \times 3.7)\ (1 - .04808 \times 0)} = 34.6$$

These analysis were both made with an Orsat apparatus from coke fires.—Submitted by F. E. PARK, Supt., Station "B" Plant, Detroit City Gas Company.

ADDENDUM TO ANSWER TO QUESTION NO. 62.

Under no circumstances is there a gas producer or water gas machine working with absolutely dry air or with pure dry carbon. A very small quantity of any gases containing hydrocarbons would vitiate results based on pure carbon. In practice it would be found exceptional for the above formula to be of any practical value.—Committee in Charge, Bureau of Information, V. F. DEWEY, Chairman.

Recent Patent Issues.

Prepared for the AMERICAN GAS LIGHT JOURNAL by ROYAL E. BURNHAM, solicitor of patents and counselor in patent causes, 833 Bond Building, Washington, D. C., from whom illustrations and specifications of any patent mentioned below may be obtained for 10 cents.

958,094. Incandescent Light. R. D. Cody, Chicago, Ills.
958,102. Gas Burner. L. De Pasquale, San Francisco, Cal.
958,126. Emergency Cut Off for Gas Pipes. M. A. Horan, Trenton, N. J.
958,185. Regulator for Gas Pumping Systems. E. Schulte, New York City, assignor to the United Coke and Gas Company.
958,245. Gas Apparatus. J. Fischer, Zurich, Switzerland.
958,261. Mantle Supporting Transportation Device. T. J. Little, Jr., Philadelphia, Pa.
958,357. Inverted Gas Fixture. G. Breck, San Francisco, Cal.
958,375. Gas Lighting Apparatus. R. M. Dixon, East Orange, N. J., assignor to the Safety Car Heating and Lighting Company.
958,381. Means for Holding Globes or Shades in the Galleries of Electric Light, Gas and Other Fittings. S. Falk, London, England.
958,506. Automatic Gas Valve. J. Hrivnak and J. Batos, Blair Station, Pa.
958,518. Hydraulic Gas Main. S. Meunier, Heaton-Chapel, England.
958,525. Gas Range Attachment. M. P. O'Donohoe, Nashville, Tenn., assignor of one-half to C. P. Ellis, same place.
958,574. Electrically Controlled Gas Igniting and Extinguishing Device. E. S. Allen, New Haven, Conn.

Special English Correspondence.

COMMUNICATED BY NORTON H. HUMPHRYS.

SALISBURY, ENGLAND, May 10, 1910.

Public Lighting at the West End.—What is a Public Lamp?—A National Bereavement.

Gas has displaced electricity in the principal thoroughfares at the West End of London, the Works' Committee of the Westminster City Council, after full consideration of tenders both from the gas and electric companies, having accepted that of the Gas Light and Coke Company. The district concerned includes Piccadilly, Regent street. Pall Mall and other well known thoroughfares, and is at present lighted by 71 electric arc lamps, of which 16 are 3,000-candle power, 26 from 1,600 to 1,800, and the remainder 1,000, and the price paid under the contract now expiring is about £17 per lamp per annum. The new tenders were for sixteen 3,000 candle lamps as before, and the remainder to be 1,800 candle, so that the total candle power was increased from 105,000 to nearly 150,000, or roughly 50 per cent. The electric company quoted £28 and £21 per lamp, for the two sizes named, respectively, and the gas company £22 and £15-10s. As the lamps are to be on the same columns, in the same position, and subject to exactly the same conditions of photometrical testing *in situ* by means of a portable photometer, with penalties for deficiency of illuminating power, the tenders are exactly on equal terms. One electricity tender involved a cost of £1,603 per annum, and that of the gas company £1,204, the present price being £1,209. So that in accepting the tender of the gas company, the Committee got 50 per cent. more light at less cost.

All sorts of conjectures, to account for the decisive defeat sustained by electricity, have been put forward by those interested in that commodity, except the right one. Some suggest that the gas company cut the thing too fine, and others that the electricity price was too high. It is not likely that the Gas Light and Coke Company with the staff they have at command, and the experience already gained in lighting Aldwych, Kingsway and Fleet street, and other important thoroughfares by means of high pressure gas lighting, have made any mistake, or that they are prepared to take the contract at a loss for the sake of the advertisement. It is equally improbable that the St. James and Pall Mall Electricity Supply Company, on such an important occasion, would go recklessly into the matter, or without a proper understanding of the conditions. The true explanation is the fact that in 1896, when the present electric contract was taken on, incandescent gas lighting was in its infancy, and the large flat flame burners then available did not yield a duty of more than 4 to 5 candles per cubic foot of gas consumed per hour, but to day, with inverted burners and high pressure, a duty of over 60 candles is available. The Westminster City Council have approached the question on the basis that candle power represents money, and that 1,000 or any other given quantity as indicated by the portable photometer is the same value irrespective of the source from which it is obtained. This assumption is not correct, as color, diffusive power and other properties are concerned in the value. A light may have certain objectionable properties that render it unsuitable for use at any price. But the point is that, on the basis taken, gas is 12 to 15 times more valuable than in 1896, and that no corresponding increment can be claimed on behalf of electricity. The fact may be unpalatable but there is no getting away from it. One might go on to claim a good deal more by comparing the cost and the quality of mantles available in the two periods named, or the cost of gas in the holder. The science and practice of gas manufacture have not been standing still during the last 15 years, nor for that matter, it is not likely to be stationary during the next 15 years.

Special reference has been made to that part of the district in which, under the new contract, gas will displace electricity, but the arrangement also includes the renewal of the lighting in certain districts already lighted by gas. The Committee asked for tenders (a) for the first installation, and (b) for the annual upkeep and maintenance per year of 3,940 hours, for five different units, viz., 90, 180, 300, 1,800 and 3,000-candle power respectively. The cost of (a) was approximately about 50 per cent. in favor of gas, in some cases considerably more, and that of (b) from 25 to 50 per cent. in favor. These figures may come as an unpleasant surprise to electricians who are accustomed to base their estimates of the value of gas upon the indications of some ancient and badly preserved fishtail burner, under the delusion that it is a fair average representation of the burner in actual use. But they have been common knowledge in the gas industry and to all independent illuminating engineers for some time, and they furnish an explanation of the fact that gas is generally preferred for public lighting, for large railway stations, etc. Some of our electrical friends, figuring on the lines above mentioned, have arrived at the conclusion that the gas for the contract will be supplied at about 4d. per 1,000 cubic feet, but a very little figuring will show that the annual consumption of gas in a 3,000-candle power lamp need not exceed 200,000 cubic feet per annum.

A somewhat curious dispute has arisen between the Corporation and the gas company at Liverpool. In that city, as in most other places, the gas company have been obliged to accept somewhat onerous conditions as regards the public lighting. And by the way, it is strange that while concessions of one kind or another are invariably put upon the gas company when it applies for powers, nothing of the sort is done in the case of electricity. Very few electric companies are under penalties as to illuminating power, or obliged to supply the public light (financially the worst paying department of any) at the lowest price obtaining in the district concerned. The question at Liverpool is, "What is a public lamp?" That the title includes lamps on the public highways is obvious. But the point is, does it include lamps on private property which is used to some extent as a public thoroughfare. It is very difficult to define what does or does not constitue a public thoroughfare. To take one case that is quite within the bounds of possibility in any of our principal ports. There may be a road extending through the docks down to the quay, a mile or more in length, inside the gates and on the exclusive property of the dock company. Probably there will be a very appreciable traffic on that road. But it is a public road, and can the gas company be called upon to light it? And if so, are they at their own expense, to lay a mile of main for the purpose of lighting perhaps 20 lamps? In regard to a thoroughfare belonging to and under the control of a local authority, the presumption is that it will be occupied to a sufficient extent to afford the gas company a renumerative return on their capital outlay, and but for the fact that this is true in 99 cases out of 100, obligations in respect to public lamps would never have been entertained for one moment. But in private roads there is no similar prospect, and the owners may have particular reasons for purposely excluding anything in the way of public business. Several other examples of lanes, passages, pathways, etc., used by the public but situated on private ground, and not under the control of the local authority, might be cited. Complications might arise if the local authority called on the gas company to light the road, and the owner either refused to allow them to lay the main, or insisted on extortionate or unpractical terms in respect to the same. Under the existing state of the law in England the question is important. The dispute at Liverpool is still *sub judice* and, therefore, one cannot do more than state the facts. In another town there were

a number of lanes or alleys leading off from main roads and serving as the entrance to anything between 20 or 100 tenements, the whole being on the property of the landlord. It became a crying necessity in the interests of public morality that this place should be lighted at night. A resolution was passed in the Council to the effect that the whole should be properly lighted. Then it was found that neither the local authority nor the gas company had powers to lay mains or put lamp posts on private ground, without the consent of the owners. In some cases the landlords, finding the lights would be appreciated by the tenants, were willing to bear the slight expense of one or two service pipes and lamps, in others they not only refused to pay anything, but also would not give permission for the gas companies' men to enter on their property. And some, on hearing that the landlords could not be compelled to pay, refused to accept the bills for fixing and supplying lamps with gas when sent in. Some of the lamps were taken out in default of payment, and there was no end of confusion and muddle. It is evidently an anomaly that any authority should have power to order lamps to be fixed in any locality that is not absolutely under their possession or control, and in respect to which they cannot grant full authority to lay mains and fix posts.

It is impossible to avoid a reference to the national bereavement that has been so much on our minds during the last 3 days. Only a week ago our King was in usual health, and it was not till Friday morning that any public announcement as to his illness was made. During the day it became evident that the position had become acute, but knowing that the King had an excellent constitution that had more than once resisted disease, there was no deep anxiety, and the announcement on Saturday morning that he had passed away shortly before midnight was a painful surprise. And there is no need for an apology in digressing from the subject proper of this letter, because the steady record of prosperity in the gas industry which it has been my privilege to send you over a period of more than 25 years could not be possible except under wise and beneficent ruling, and it is a matter of common knowledge that the late King, following the footsteps of his father, did all he could to encourage art and manufacture and to enliven the position of the working classes. The foreign papers have recognized and endeavored to indicate the relations that prevailed between the King and his people. Their best efforts cannot too strongly emphasize the fact that he was more than a ruler. He was a brother who lived with and among his people, not above them, and it is the exception to meet anyone in our streets to-day who is not wearing some sign of mourning or who does not feel the regret that attends the loss of a personal friend. It has been well said that he was a manly King and a Kingly man. While he exhibited to a marked degree the attributes that go to make a good monarch, his cheerful good nature and geniality appealed to our hearts. It is not enough to say that he never gave offense. He never failed to perceive and to act upon the opportunity to make anyone happy. One could occupy pages in amplifying this point, but I will only quote one instance that occurred in this neighborhood. The King and Queen had been visiting in the country and were about to entrain for the return journey at a small station when they learned that the little 8-year-old daughter of the station superintendent had been stricken with blindness a few months since, and was at that moment bewailing the affliction that prevented her seeing them. A quick glance of comprehension passed between the royal pair. Time was up, but the King continued to converse with his host and hostess, while the Queen went quickly to the little girl, took her in her arms, kissed her and prayed for her that the affliction might not be without compensation. The pages of history will not be silent as to the position taken by Edward VII. in the affairs of the world, but it is remembrances of this sort that are chiefly responsible for the dimness in our eyes to-day.

Items of Interest
FROM VARIOUS LOCALITIES.

"L. G.," writing from Easton, Pa., under date of the 21st inst., incloses the following: "Mr. W. E. Quillen, of Montgomery, Ala., has succeeded Mr. D. M. Coughlin as Manager of the Easton Gas and Electric Company. The latter goes to Spokane Falls, Wash., to assume charge of the New Business Department of the Spokane Falls Gas Company. Mr. Coughlin has been located in Easton for the past 18 months, during which period he made a host of friends for himself and secured scores of customers for the Company. He had charge of the publicity end of the installation of the monster electric sign slogan erected by the Company in Easton, as a result of which agitation it is generally conceded there came about the rehabilitation of the Easton Board of Trade."

Some time ago the proprietors of the Union Light, Heat and Power Company, of Fargo and Moorehead, North Dakota and Minnesota, advertised that they would give away, without charge absolutely, and connect up the same free, 100 gas ranges, of the Detroit Jewel double oven range type, the awards to be made to those who first applied at the Company's office. This offer met with such great favor that the 100 ranges were disposed of within 10 days, and the howl for more (clamor likely would sound better than howl) that smote the air nerved the Company to put out a second and last instalment of 100 under like terms. The effect of the output of this wholesale placing was immediate and satisfactory.

This appears to show that some who are benefited by changing from one system to another are willing to bear testimony in public to the fact. The evidence is in the shape of a letter recently sent to President Cowdery, of the Peoples Gas Light and Coke Company, of Chicago, by Mr. Otto Shulz, President of the Werner Piano Company, of Chicago, which explains itself: "Yours of the 27th to hand, and in reply wish to say that we have found, in using gas in connection with the new boiler which you put in for us last spring, that we have been able to save several times the cost of installing this plant within the time that we have used it. We consider it one of the greatest money-making changes that we have adopted for some time. We use some heat for creating steam for glueing purposes and find that your gas boiler gives us just as much heat as we need, and as this can be operated on less than 10 pounds of steam pressure, we are able to handle it without the necessity of a licensed engineer and, in consequence, we are able to save the expense. Besides, we find that the gas costs us considerably less than the coal did heretofore, when we were raising this steam by the use of coal as fuel."

Send to the Bristol Company, Waterbury, Conn., for a copy of its latest Bulletin, No. 125, which describes to a nicety Bristol's Class I., Self Recording Thermometers for recording temperatures at the point where the instrument itself is located. The Company asserts that these instruments are now being used to very good advantage for reading temperatures in cold storage plants. The plan and practice of these instruments are well shown on page 3 of the Bulletin, where a record is given of the temperature maintained in the egg storage room (cold) of a large cold storage and warehouse company.

A contract for a new water gas set, of the dimension of 6½ feet, to be installed on the Freeport plant of the Nassau and Suffolk Lighting Company, of Hempstead, L. I., has been awarded to the United Gas Improvement Company.

The Haverhill (Mass.) Gas Light Company's offer to put the selling rate, now at 90 cents per 1,000 cubic feet, at 85 cents, July, 1911, and at 80 cents when the output reaches 450 millions cubic feet, has been accepted by the authoriiies.

The Windsor (Conn.) Gas Light Company is extending its mains to the outlying districts of Cheshire and West Cheshire.

Messrs. A. J. Franklin, H. Shropshire and Charles E. Gaskill have incorporated the Downe Township Gas Company, to operate a gas plant in the township of Downe, Cumberland County, N. J. It is capitalized in $25,000.

The Pacific Gas and Electric Company, of San Francisco, Cal., has subscribed $100,000 of stock in the proposed Panama-Pacific International Exposition Company, which is arranging for an International Fair to be held some time on the Pacific Coast in the year 1915.

Mr. A. S. B. Little, writing under date of the 21st inst., from St. Louis, Mo., says that the natural oxide which was recently reported found in great quantities in a certain Western district, has been

thoroughly tested and has been pronounced perfect for gas purifying purposes. Our informant, who accidentally made the discovery of these deposits, informs us that a company will be formed to put it on the market in a mixed and clean condition ready for use. The practical test was made in New York, and further tests are being conducted in St. Louis, Nashville and Detroit.

THE Amherst (Mass.) Gas Company has been awarded the contract for the public lighting of the outlying district of Hatfield, under an agreement to maintain 37 lamps, on a moontable basis, at the rate of $18 per lamp per annum.

THE San Diego (Cal.) Consolidated Gas and Electric Company is extending its gas mains to the district known as City Heights, and its electric conduits to La Wesa and Chula Vista.

AT last Stratford, Conn., is to have a gas service, and it is to be laid on by the logical supplier, the Bridgeport Gas Company.

THE Gas Bench Construction Company, of St. Louis, Mo., has been awarded the contract for the benchwork that is to be constructed in the works now being erected by the Asheville (N. C.) Electric Light Company, to supply gas to the place last named.

THE franchise to construct and operate a gas works in Antigo, Wis., that was originally granted to one O. B. Kohl, has been assigned by him to the first named concern.

MR. E. M. BEAM has been appointed manager of the commercial division of the Knoxville (Tenn.) Gas Company vice Mr. R. J. Chesney, who assumes charge of the new business division of the Spokane Falls (Wash.) Company.

MR. WILLIAM HENRY SMITH, for many years on the superintending staff of the U. G. I. Company, Philadelphia station, died at his home, South Broad street, Philadelphia, May 17th. He was in his 60th year, and prior to the taking over of the plant by its present lessees, had served on the Board of Trustees, Philadelphia City Gas Works, for quite a period. In all his service in the gas supplying of the Quaker City covered almost two score years.

THE combined net earnings available for dividends of the subsidiary Companies of the Massachusetts Gas Companies for April last was equal to an increase of 20.60 per cent., compared with the like returns for April, 1909. The earnings for March, 1910, exceeded those for 1909, in the sum of 15.94 per cent.

THE Glidden Varnish Company, of Cleveland, O., the acid-proof coatings from the factories of which are well and favorably known to gas engineers, has gotten out a nicely printed pamphlet that lucidly describes its wares. Write to the address (Cleveland, O., will prove sufficient direction) for a copy of it, and the Company will forward it forthwith.

WE understand that the Messrs. Runyan (A. C. & C. A.) and L. F. Ryall positively propose to complete the works of the Sturgis (Mich.) Gas Company this summer. Mr. Ryall is a resident of Escanaba, Mich.

MR. T. G. CREED, formerly business and commercial manager for the Spokane Falls (Wash.) Gas Light Company, has opened an office in Spokane where he proposes to carry on an auction business under the title of the Northwestern Auction Company.

THE Gas Bench Construction Company, of St. Louis, is under contract to furnish the necessary water gas linings and checkerbrick for the new water gas sets that are being installed in East St. Louis, Bloomington and Decatur, Ills.; Denver, Col.; Detroit and Battle Creek, Mich.; Houston, Tex.; Ottumwa, Ia.; Salt Lake City, Utah, and New Orleans, La.

"J. L. S.," writing under date of the 20th inst., inclosed the following clipping from the Hartford *Courant*: "Mr. Alexander J. Campbell, of New London, was in Hartford yesterday afternoon, and as General Manager for the Rockville-Willimantic Lighting Company and the Willimantic Gas and Electric Light Company, authorized a change in the management of the Willimantic Gas and Electric Company. Mr. F. C. Slade, who came to Willimantic from Yonkers, N. Y., about a year ago, is succeeded by Mr. W. M. Lewis, Manager at Rockville, who is one of the Directors of the Willimantic-Rockville Company. He will not remove to Willimantic, but will have his headquarters in Rockville, and will manage the Companies in Rockville, Willimantic and Stafford Springs. Mr. W. E. Haskins, who has been Superintendent of the Willimantic gas and electric plants for several years, will be Superintendent for the entire Rockville-Willimantic system, having charge of the manufacturing end of the business, but not of the distribution division. The new high-tension line is now in operation, supplying electric current from the Uncas Power Company's plant, at Scotland, to the Willimantic, Rockville and Stafford Springs plants."

ADVICES from Denver, Col., are to the effect that the reorganization of the Denver Gas and Electric Company is down for accomplishment to-morrow, at an adjourned meeting of the shareholders. Mr. Henry L. Doherty, President of the Company, and Myron T. Herrick, one of its largest shareholders, will be on hand, and it is understood that, unless an arrangement is perfected in the meanwhile, whereby the Gas Company will become the local distributers for the big power concern, the Central will announce its intention to apply for a franchise to operate in Denver. The Denver Gas and Electric Light Company was incorporated several months ago, with $10,000,000 capital, to take over the present Company. None of the present Board of Directors was elected to the new Company, but they are still in possession of the property. The transfer of the assets of the present Company to the new organization will take place when the final plans therefor are consummated. The new Company authorized a $25,000,000 bond issue to provide the funds for the deal; but its only acquisition so far is the plant of the Denver Steam Heating Company.

"L. S.," writing from Chicago, Ills., remarks: "What are said to be among the largest monoliths in the country are being erected in the construction of the office building of the Peoples Gas Light and Coke Company, of Chicago, at Michigan avenue and Adams, that city. These mammoth pillars are 4 feet in diameter, 26 feet in height, and weigh 28 tons. They cost $3,200 each. They were quarried, at a depth of 100 feet, in a quarry, at Cape Ann, Mass., near Rockport. Having been quarried they were raised and loaded on flat cars, built especially to carry them to the Cape, where they were transferred to a boat to Boston, where they were polished, and shipped on flat cars to Chicago."

THE friends of Mr. Norman G. Kenan, President of the Union Gas and Electric Company, of Cincinnati, will be glad to hear that he is recovering rapidly from the serious illness that beset him early this month.

THE Board of Gas and Electric Light Commissioners of Massachusetts has assented to the petition of the Citizens Gas Light Company, of Quincy, Ills., to issue $140,000 new capital, to be issued at the rate of $100 per share.

ADVICES from Louisville, Ky., dated the 23d inst., assert that the city ordinance fixing the salary of the Inspector of Gas and Meters in that city there at $1,800 per annum is void, and that the enactment of the General Assembly in 1888, was created, fixing the salary at $3,000, is legal. Such is the opinion handed down by Judge Gordon and rendered a day or so ago. This opinion sustains the contention of Gas Inspector John W. Vreeland, in his plea for the construction of the ordinance fixing the salary. The Legislature fixed the salary at $3,000 per annum in 1888. In April, 1908, the General Council of the city of Louisville adopted an ordinance reducing the compensation to $1,800 per annum. When Mr. Vreeland assumed office he filed suit asking the court to determine for him whether the law of the Legislature or the ordinance of the General Council should be considered operative."

MR. G. L. BRUNDRETT, in taking hold of the position in the gas management of the Kansas City Gas Company, made vacant by the death of Mr. McGowan, said: "There will be no changes in the management of the Kansas City Gas Company. I have visited Kansas City many times and was associated with Mr. McGowan. I shall make no changes in his methods."

THE AMERICAN GAS LIGHT JOURNAL

A. M. CALLENDER & CO.,
PROPRIETORS.

MONDAY, MAY 30, 1910.

The Market for Gas Securities.

Consolidated gained 3⅜ points in the bid price for the week as the result of the trading in that period. At noon to-day (Friday) the rates were 141 to 141½. During the week a fair demand for city gas bonds was kept up, the bargain hunters appearing in larger numbers than in any week's period since February last. The writer has noted for years that the appearance of these shrewd ones betokens a better market.

Brooklyn Union is decidedly strong, at 147 to 148½, and much of this steadiness is undoubtedly due to the changing of the dividend period to quarterly instead of spasmodically. Out-of town shares, notably the Massachusetts Gas issues, are bettering all the time. Remember our recent statements in the instance of Washington gas. It is 350 bid.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

115 BROADWAY, NEW YORK CITY.

MAY 30.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked*
Consolidated Gas Co.	$78,177,000	100	141	141¼
Central Union Gas Co.— 1st 5's, due 1972, J. & J.	3,000,000	1,000	98	101
Equitable Gas Light Co.— Con. 5's, due 1932, M. & S.	1,000,000	1,000	—	105
Mutual Gas Co.	3,500,000	100	155	165
New Amsterdam Gas Co.— 1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	100	101½
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	35	50
1st Mtg. Gold Bds. 5 p. ct.	1,000,000	—	98¼	100½
New York and East River— 1st 5's, due 1944, J. & J.	3,500,000	1,000	104	107
Con. 5's, due 1945, J. & J.	1,500,000	—	97	101
Northern Union— 1st 5's, due 1927, J. & J.	1,250,000	1,000	94	100
Standard	5,000,000	100	—	75
Preferred	5,000,000	100	70	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	100	105
The Brooklyn Union	15,000,000	1,000	147	148½
1st Con. 5's, due 1948, M. & N.	15,000,000	—	106¾	107
Yonkers	299,550	509	190	—
Out-of-Town Companies.				
Bay State	50,000,000	50	.65	.70
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	65
" 1st Mtg. 5's	509,000	1,000	90	96
Boston United Gas Co.— 1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	73	73½
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed Gold Bonds	7,000,000	1,000	104	106¼
Cincinnati Gas and Electric Co.	29,500,000	100	92	93
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. & Heating Co.	1,682,750	100	90½	91
Preferred	3,026,500	100	75½	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	—	105
Mortgages, 6's	3,600,000	—	—	118
Chesapeake, 1st 6's	1,000,000	—	—	—
Equitable, 1st 6's	910,000	—	—	—
Consolidated, 1st 5's	1,490,000	—	—	112
Consolidated Gas Co. of N. J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	—	—	100
Denver Gas and Electric	458,000	—	102	105
Detroit City Gas Co	5,000,000	50	—	50
" Prior Lien 5's	4,619,000	1,000	97	100½
Detroit Gas Co., 5's	381,000	1,000	75	80
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	39	40
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co., 1st Mtg. 5's	1,225,000	1,000	104¾	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	—	112	113½
" Bonds, 5's	10,500,000	—	103	103¾
Indianapolis	2,000,000	—	60	70
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	—	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede Gas Co., St. Louis	10,000,000	100	104¾	105
Preferred	2,500,000	100	90	100
Bonds	10,000,000	1,000	102½	103
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,370,000	50	143	145
Madison Gas and Electric Co. " 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	60	60½
Massachusetts Gas Companies, of Boston	25,000,000	100	84	84¼
Preferred	25,000,000	100	90	91
Montreal Gas Co., Canada	2,000,000	100	218	218¾
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	56	58
Bonds, 6's	6,000,000	—	137	138
New Haven Gas Co.	2,000,000	25	200	—
Peoples Gas Lt. & Coke Co., Chicago	25,000,000	100	107¾	108¼
1st Mortgage	20,100,000	1,000	—	—
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104¾	105½
San Francisco Gas Co., Cal.	15,500,000	—	—	—
St. Joseph Gas Co.— 1st Mtg. 5's	751,000	1,000	100	102
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgages, 6's	650,000	1,000	113	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	90	95
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	100	104
Washington (D. C.) Gas Co.	1,600,000	200	350	352½
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	361	—

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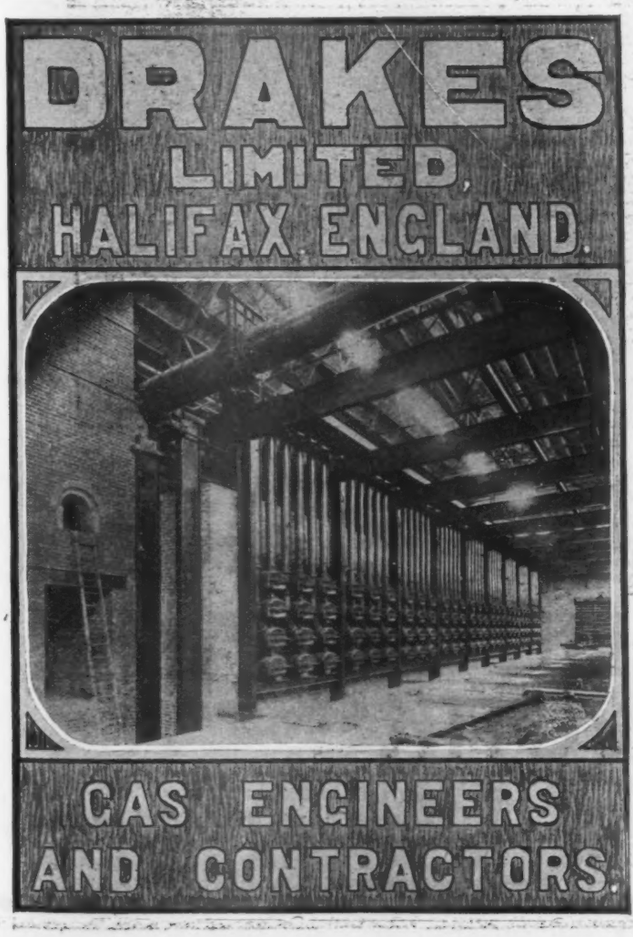

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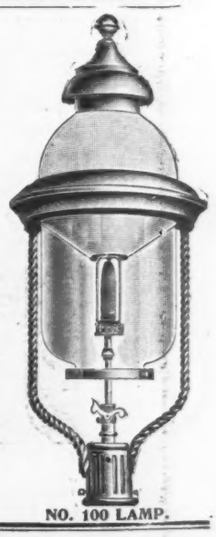

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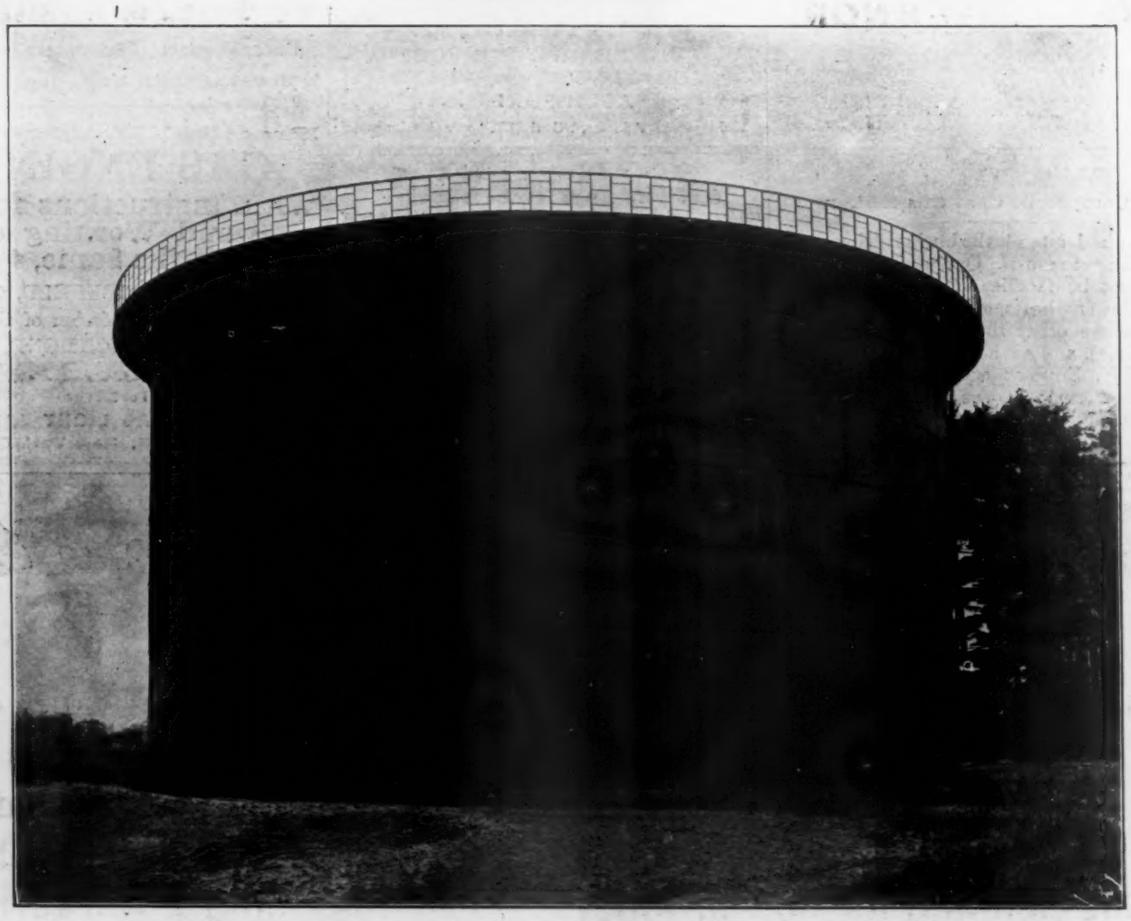

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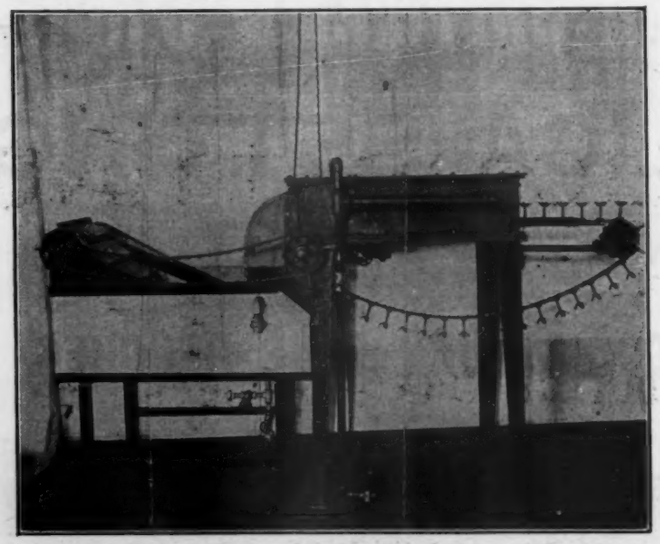

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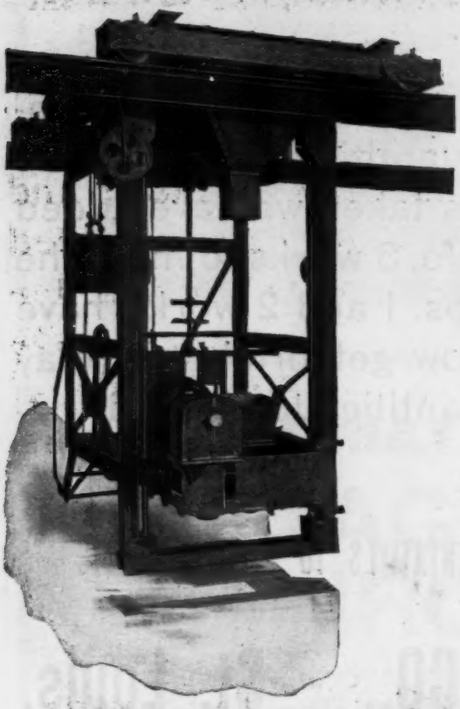

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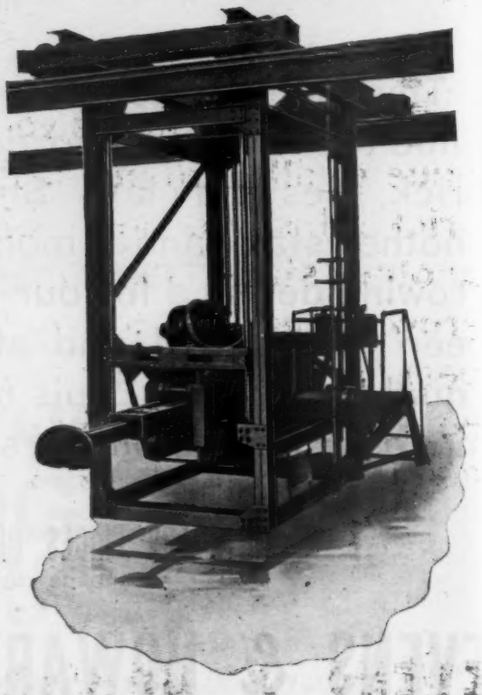

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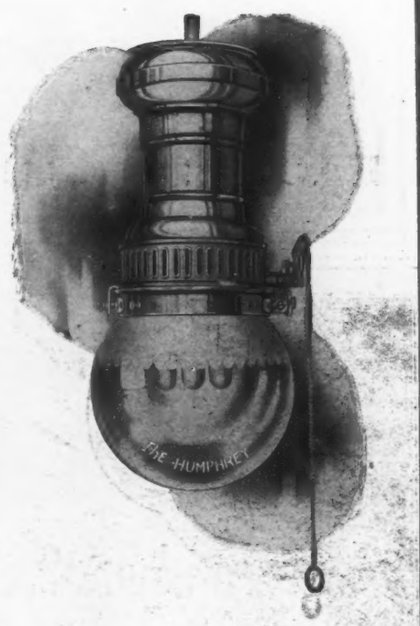

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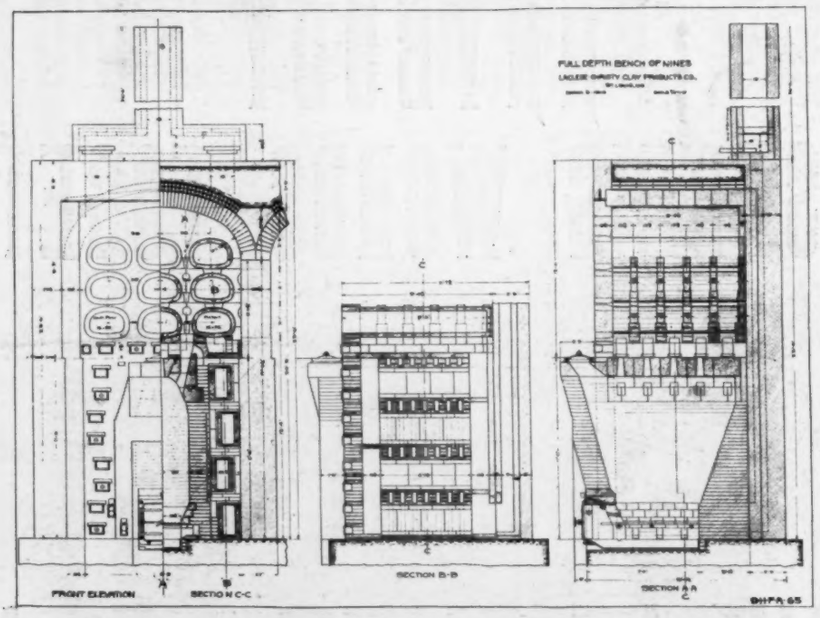

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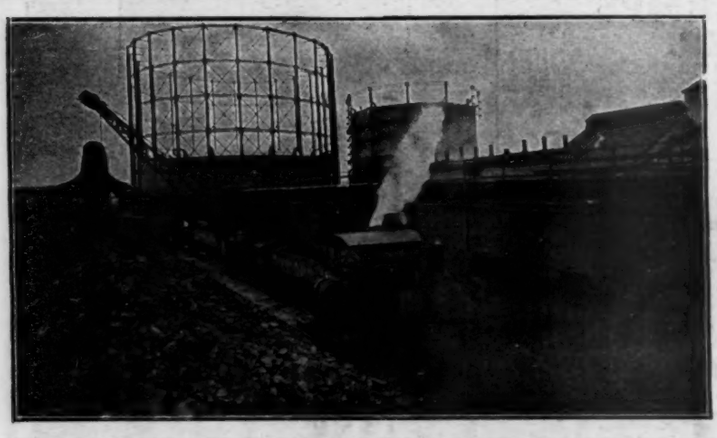

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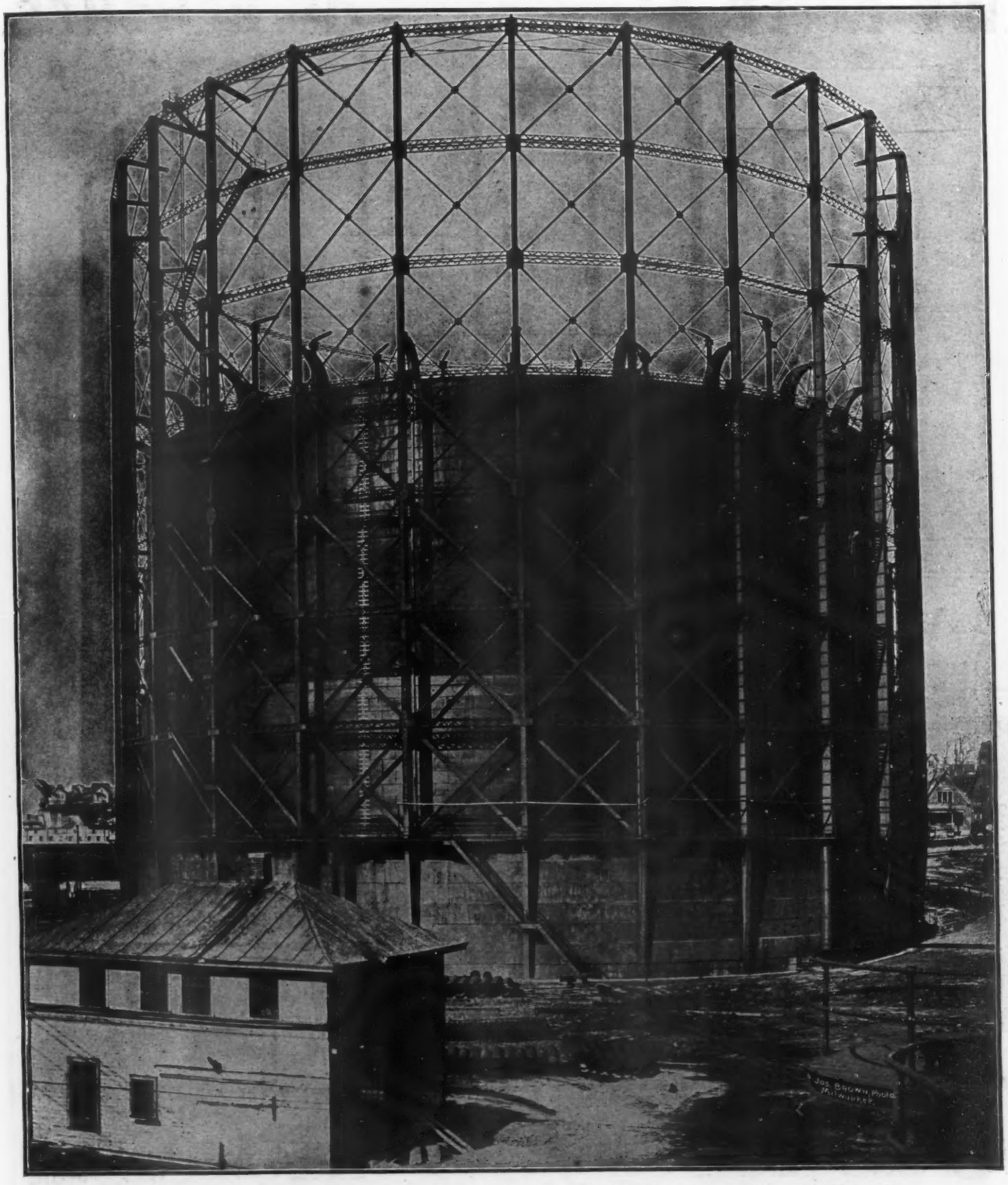

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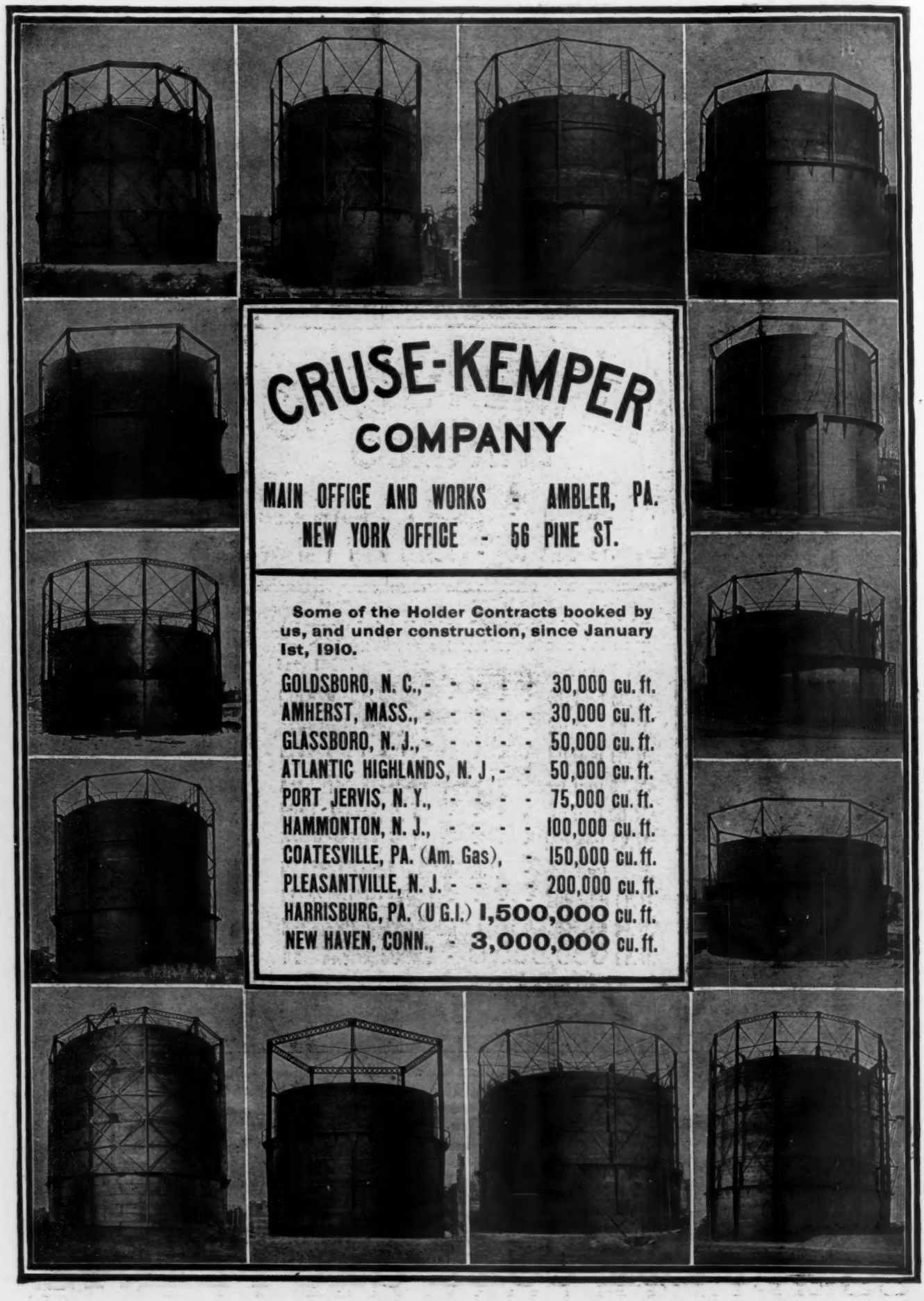

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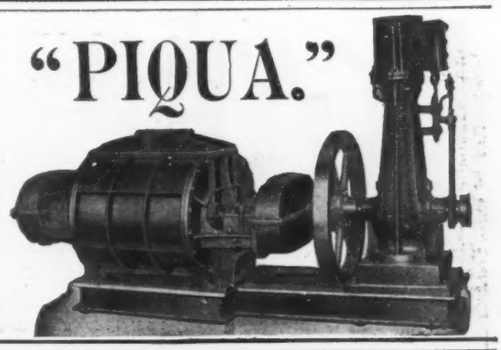

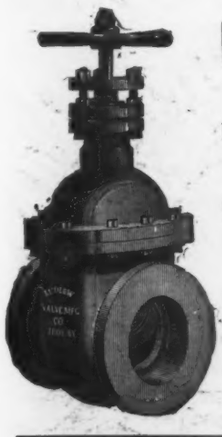

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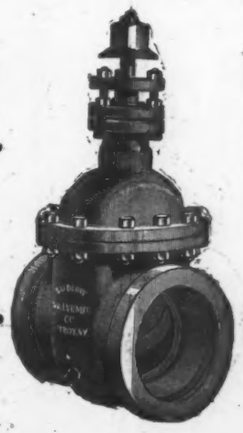

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						From Time Given.	
		P.M.				P.M.	A.M.
Wed.	1	7.50	2.40 A.M.	Wed.	1	7.12	3.17
Thu.	2	7.50	3.00	Thu.	2	7.12	3.17
Fri.	3	7.50	3.30	Fri.	3	7.12	3.17
Sat.	4	7 50	3.30	Sat.	4	7.17	3.12
Sun.	5	8.00	3.30	Sun.	5	7.17	3.12
Mon.	6	8.00	3.30	Mon.	6	7.17	3.12
Tue.	7	8.00 N.M.	3.30	Tue	7	7.17	3.12
Wed.	8	8.00	3.30	Wed.	8	7.17	3.12
Thu.	9	8.00	3.30	Thu.	9	7.17	3.12
Fri.	10	8.00	3.30	Fri.	10	7.17	3.12
Sat.	11	8.00	3.30	Sat.	11	7.17	3.07
Sun.	12	11.00	3.30	Sun.	12	7.17	3.07
Mon.	13	11.30	3.30	Mon.	13	7.17	3.07
Tue.	14	11.50 F.Q.	3.30	Tue.	14	7.17	3.07
		A.M.					
Wed.	15	12.10	3.30	Wed.	15	7.17	3.07
Thu.	16	12.30	3.30	Thu.	16	7.17	3.07
Fri.	17	1.00	3.30	Fri.	17	7.17	3.07
Sat.	18	1.20	3.30	Sat.	18	7.22	3.07
Sun.	19	1.50	3.30	Sun.	19	7.22	3.07
Mon.	20	2.20	3.30	Mon.	20	7.22	3.07
Tue.	21	No L.	No L.	Tue.	21	7.22	3.07
Wed.	22	No L. F.M.	No L.	Wed.	22	7.22	3.07
Thu.	23	No L.	No L.	Thu.	23	7.22	3.07
Fri.	24	8.00 P.M.	10.30 P.M.	Fri.	24	7.22	3.07
Sat.	25	8.00	11.10	Sat.	25	7.27	3.07
Sun.	26	8.00	11.50	Sun.	26	7.27	3.07
Mon.	27	8.00	12.10 A.M.	Mon.	27	7.27	3 07
Tue.	28	8.00	12.40	Tue.	28	7.27	3.07
Wed.	29	8.00 L.Q.	1.10	Wed.	29	7.27	3.07
Thu.	30	8.00	1.30	Thu.	30	7.27	3.07

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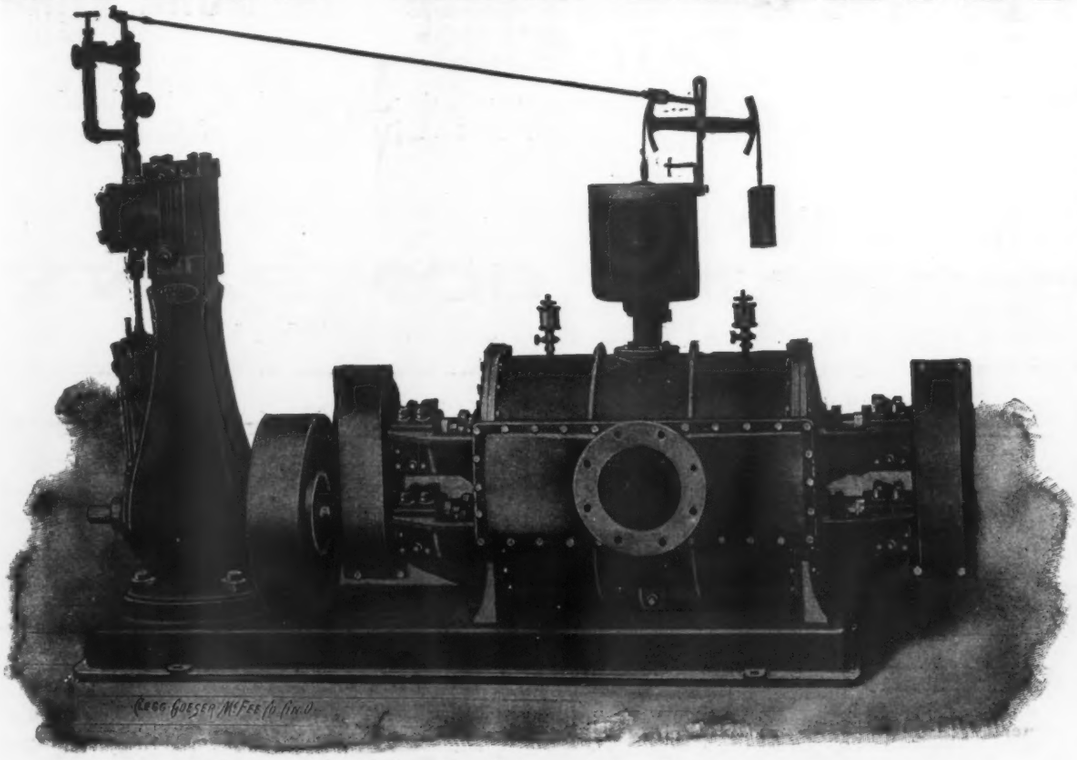

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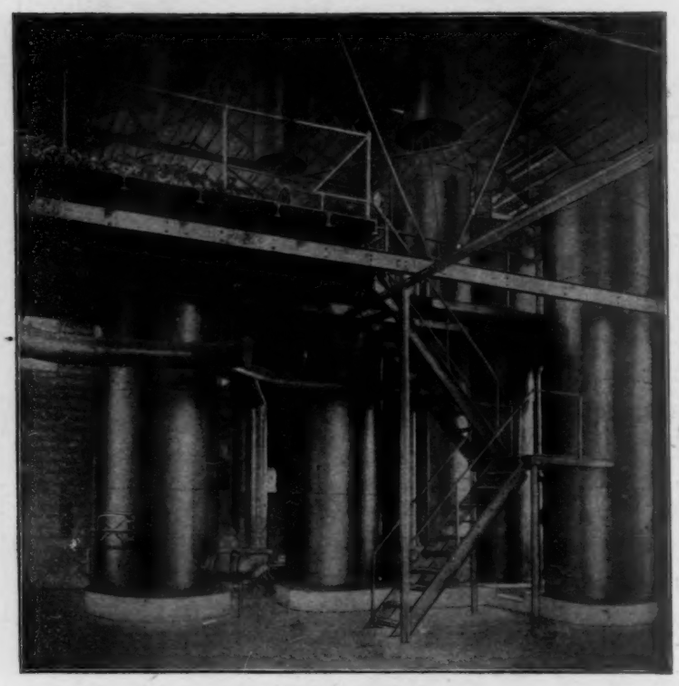

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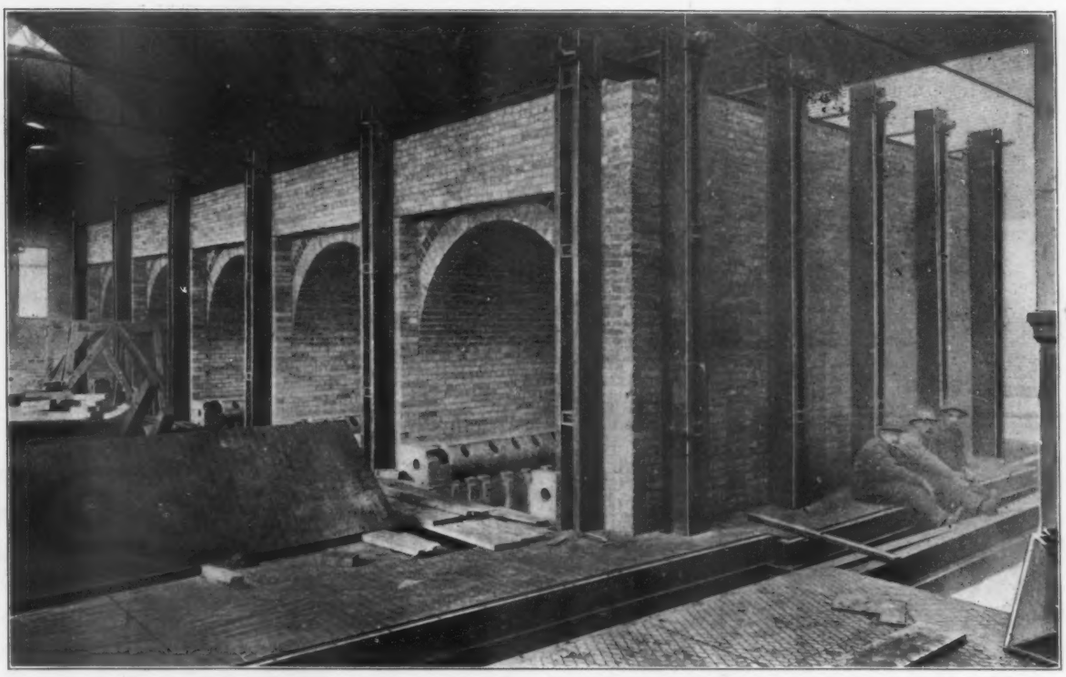

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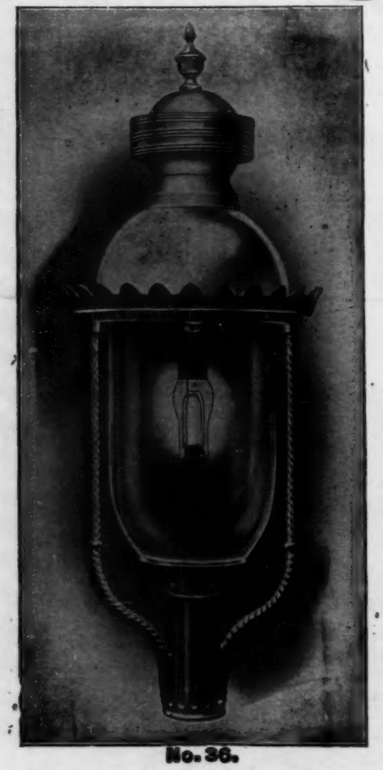

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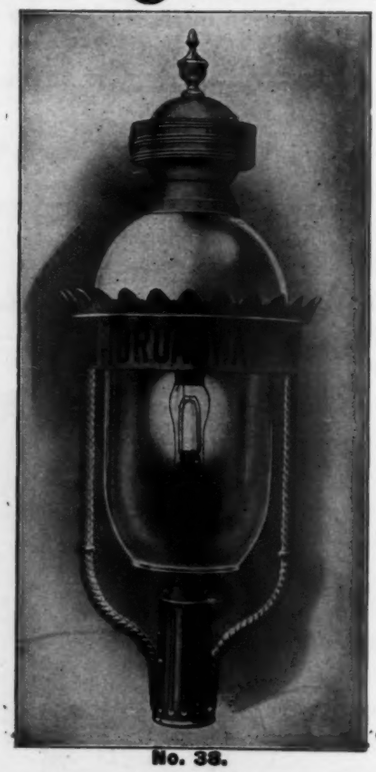

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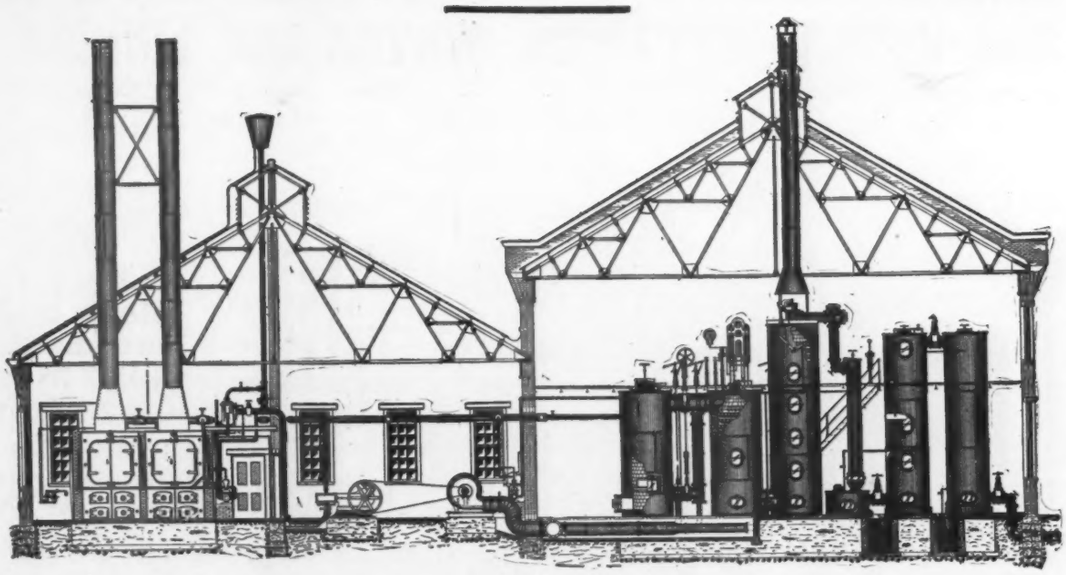

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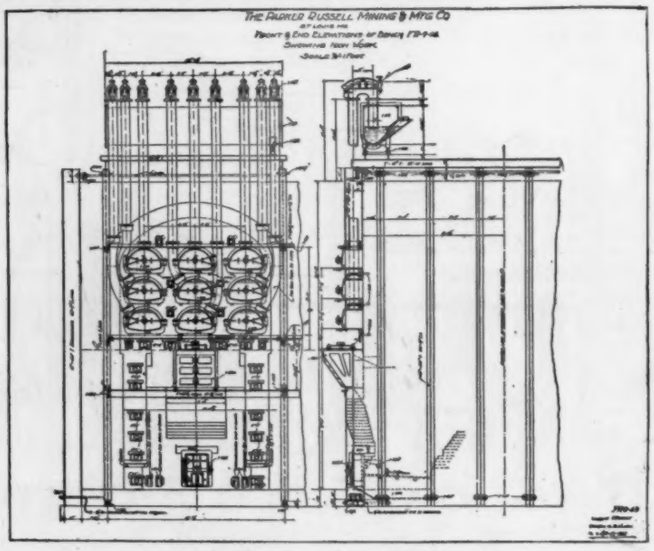

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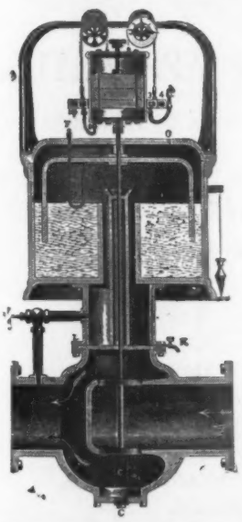

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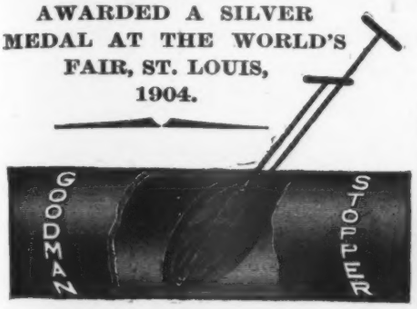

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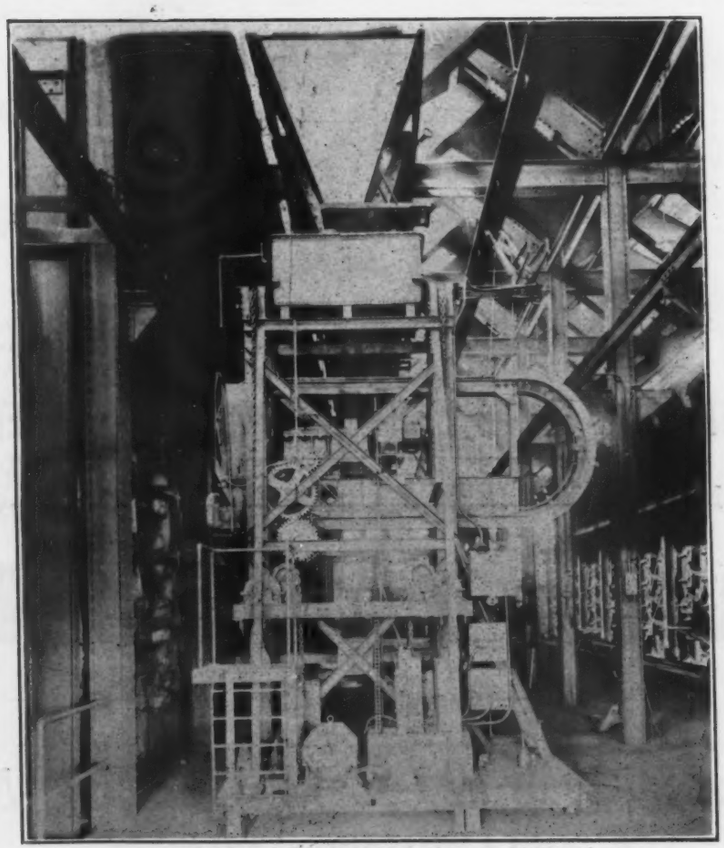

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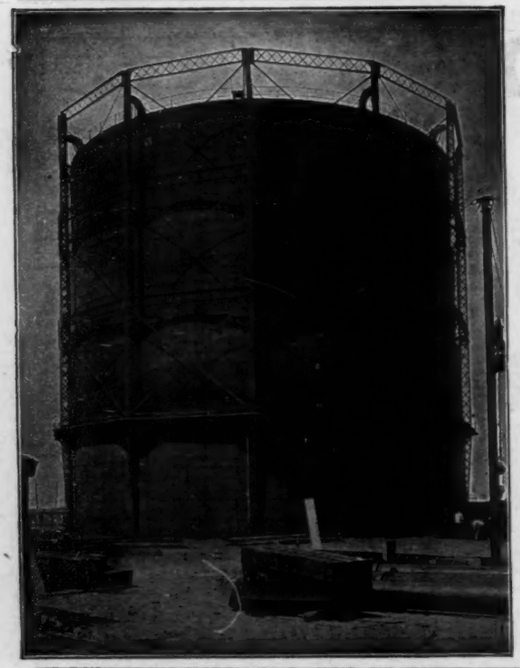

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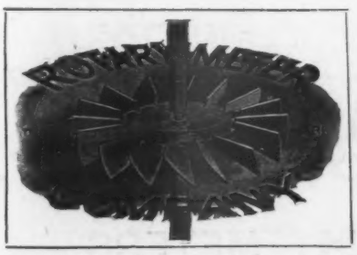

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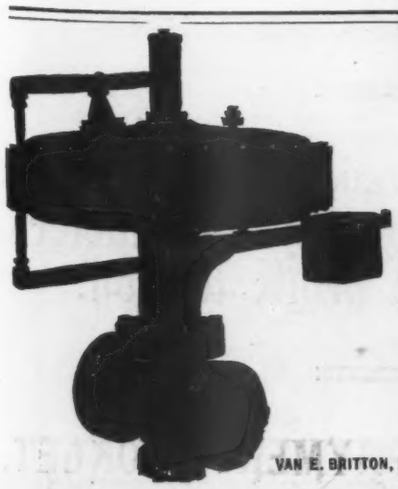

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